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Gray's Telephonic Inventions.

BY PROF. EDWIN J. HOUSTON.

Among the names of the distinguished scientific men who have aided in the production of the speaking or articulating electric telephone, that of Elisha Gray, of Chicago, occupies no mean position. Like most of those who aided in the invention of this marvelous instrument, the work of Mr. Gray leading towards his part of this invention dated from a time several years prior to his production of a working instrument.

The part played by Mr. Gray in the invention of the electric telephone was the natural outgrowth of his conception of his system of multiplex-harmonic telegraphy. In this system of telegraphy by means of which the multiple transmission of messages is rendered electrically possible, all the characteristics of musical sounds, the pitch, the intensity and the quality, are caused to impress their peculiarities on an electrical current, which is transmitted through a conducting wire, and is caused, by suitable electrical appliances, to reproduce, at the receiving end of the line, the peculiarities of the sounds impressed on it at the transmitting end. Mr. Gray invented this system of multiple electric transmission early in 1874. His method consists substantially in sending into the line, by the vibration of tuning-forks, or tuned reeds, separate series of electrical impulses, that vary both in their strength and in their rapidity. There is thus charged on the line electrical impulses varying considerably both in their rapidity and in their strength.

At the distant end of the line a series of electro-magnets are placed, the armatures of which are rigidly attached at one of their ends to one of the poles, the other end being free to vibrate towards and from the free pole. If then the end of the line be connected to a number of different electro-magnetic receivers, the rate of vibration of which exactly corresponds with the rate at which the separate series of electrical impulses were sent into the line, each of the receivers will be actuated by those electrical impulses, that correspond in frequency to the frequency with which it swings, and by those impulses alone. A number of independent messages, therefore, can thus be sent over the line without in any respect interfering with one another.

Mr. Gray carried on an extensive series of experiments with his multiple-telegraph apparatus, the natural outgrowth of which resulted in his filing in the United States Patent Office, on the 14th of February, 1876, a caveat for "a new art of transmitting vocal sounds telegraphically." In this caveat he specifically states, "It is the object of my invention to transmit the tones of the human voice through a telegraphic circuit, and reproduce them at the receiving end of the line, so that actual conversation can be carried on by persons long distances apart."

Singularly enough, this specification was filed in the United States Patent Office on the same day that Alexander Graham Bell filed his specification for "a method of, and apparatus for, transmitting two or more telegraphic signals simultaneously along a single wire by the employment of transmitting instruments, each of which occasions a succession of electrical impulses differing in rate from the others; and of receiving instruments, each tuned to a pitch at which it will be put into vibration to produce its fundamental note by one only of the transmitting instruments." This is the specification on which Bell rests his claims for the invention of his first articulating telephone.

Thus it will be seen that by a remarkable coincidence these two applications for government protection for the invention of telephones were not only filed on the same day, but were also the direct outgrowth of two very similar systems of multiple electric telegraphy.

In Fig. 1, shown the instrument as figured in Mr. Gray's caveat of February 14, 1876.

In this early form of instrument the transmitter is shown at *A*. The instrument, therefore, belongs to that class of telephones in which the voice of the speaker is caused to vary an electrical current by producing variations in the resistance of its circuit.

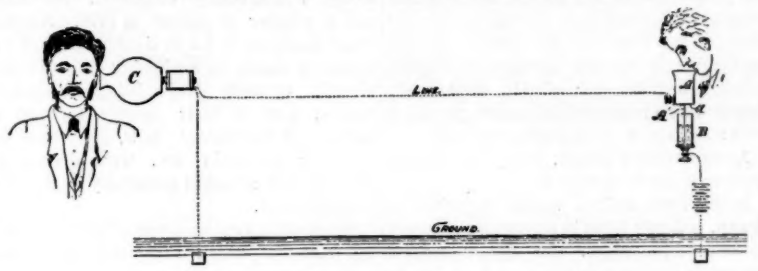


FIG. 1.—GRAY'S FIRST ARTICULATING TELEPHONE (CAVEAT DESIGN).

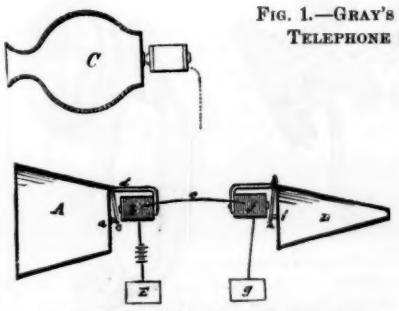


FIG. 2.—BELL'S ORIGINAL INSTRUMENT.

FIG. 4.—BELL'S MODIFIED RECEIVER (ELEVATION).

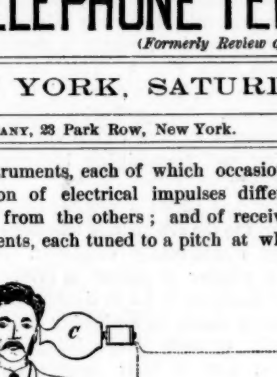


FIG. 6.—GRAY'S BI-POLAR TELEPHONE.

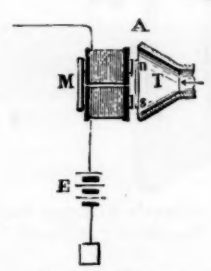


FIG. 3.—BELL'S MODIFIED TELEPHONE RECEIVER (SECTION).

FIG. 5.—GRAY'S TELEPHONE RECEIVER.

In Fig. 1, a battery, grounded at one end as shown, has its other terminal connected to the vessel *B*, "filled with some liquid possessing high resistance, such, for instance, as water, so that the vibrations of the plunger or rod A^1, which does not quite touch the conductor *b*, will cause variations in the resistance, and, consequently, in the potential of the current passing through the rod A^1." The part quoted is taken from the language of the caveat.

The mouth-piece, *A*, has attached to it a diaphragm, *a*, "of some thin substance, such as parchment or gold-beaters' skin, capable of responding to all the vibrations of the human voice, whether simple or complex."

A receiving instrument is shown at the other end of the line, at *C*, and consists of "an electro-magnet of ordinary construction, acting upon a diaphragm to which is attached a piece of soft iron, and which diaphragm is stretched across a receiving vocalizing chamber, *C*, somewhat similar to the corresponding vocalizing chamber *A*."

"The diaphragm at the receiving end of the line is thus thrown into vibrations corresponding with those at the transmitting end, and audible sounds or words are produced."

"The obvious practical application of my improvement will be to enable persons at a distance to converse with each other through a telegraphic circuit, just as they now do in each other's presence, or through a speaking tube.

"I claim as my invention the art of transmitting vocal sounds or conversations telegraphically through an electric circuit."

The invention thus embodied by Gray in his caveat of 1876, he claims, was conceived by him at a much earlier date, but owing to press of other electrical work, was not embodied in an actual written description until shortly before the time of filing the caveat. The idea of the invention was suggested to him by the string telephone, and an examination of Fig. 1, will show that he has, to a certain extent, copied this instrument electrically.

Unfortunately for Gray, he did not have a working model of his telephone completed until after Bell had modified the instrument described in his application for letters-patent, filed on the same day as that on which Gray deposited his caveat in the Patent Office. We say unfortunately, since Gray's first instrument would transmit intelligible, articulate speech, while Bell's original instrument would not.

In order the better to compare the invention set forth in the caveat of Gray with that of Bell, we will annex a short description of that part of the apparatus described in Bell's application of February 14, 1876, the application that is claimed to cover the invention of a telephone for the electrical transmission of articulate speech. This form of instrument is shown in connection with Fig. 2, which is taken directly from Fig. 7 of Bell's specification.

This apparatus is described in his specification as follows, viz.:

"The armature *c*, is fastened loosely by one extremity to the uncovered leg *d*, of the electro-magnet *b*, and its other extremity is attached to the center of a stretched membrane, *a*. A cone, *A*, is used to converge sound-vibrations upon the membrane. When a sound is uttered in the cone the membrane *a*, is set in vibration, the armature *c*, is forced to partake of the motion, and thus electrical undulations are created upon the circuit *E*, *b*, *e*, *f*, *g*. These undulations are similar in form to the air vibrations caused by the sounds; that is, they are represented

graphically by similar curves. The undulatory current passing through the electro-magnet *f*, influences its armature *h*, to copy the motion of the armature *c*. A similar sound to that uttered into *A*, is then heard to proceed from *I*."

This instrument does not appear to have been capable of transmitting intelligible, articulate speech in the form in which it is figured and described in Bell's early specification. The best results he was able to obtain from it were faint sounds, heard by his assistant, but not verified by Bell. Or, quoting the language employed by Bell in a lecture delivered before the Society of Telegraph Engineers, October 31, 1877: "The results were unsatisfactory and discouraging. My friend Mr. Thomas A. Watson, who assisted me in this first experiment, declared that he heard a faint sound proceed from the telephone at his end of the circuit, but I was unable to verify his assertion. After many experiments attended by the same only partially successful results, I determined to reduce the size and weight of the spring as much as possible. For this purpose I glued a piece of clock spring, about the size and shape of my thumb nail, firmly to the center of the diaphragm, and had a similar instrument at the other end; we were then enabled to obtain distinctly audible effects."

Before Gray had a working model made in accordance with his caveat, Bell modified his apparatus in the manner above described, and had successfully transmitted intelligible, articulate speech. This was unfortunate for Mr. Gray, since his apparatus, when constructed as described in his caveat, acted successfully as a speaking telephone. Bell, having first reduced his invention to practice, was successful in establishing his rights over those of Gray. From the record, however, Gray is clearly entitled to at least share with Bell the honor for the invention of this form of articulating telephone.

The modified form of Bell receiver, by means of which he obtained his first satisfactory, intelligible, articulate speech, is similar to that shown in section, Fig. 3.

This receiver consists, as shown, of an electro-magnet, *M*, opposite the poles of which is a tightly-stretched membrane which closes a mouth-piece *T*. A piece of watch-spring in the form of a permanent magnet, *n*, *s*, is rigidly attached to the middle of the membrane. This modified form of receiver is shown in elevation in Fig. 4.

Continuing his experiments as to the most favorable conditions for the proper working of his telephone, Bell made numerous experiments as to the influence produced by variations in the size of the different parts. Among other things, he gradually increased the size of the magnet fastened to the diaphragm of gold-beater's skin, until at last he entirely replaced the gold-beater's skin diaphragm by one of iron, and thus vastly improved the efficiency of his instrument.

While experimenting on the simultaneous multiple transmission of various tones electrically, Gray made several forms of receiving instruments for causing such tones to be heard at the distant end of the line. One of these, which was devised some time before the form shown in the caveat of February 14, 1876, was suggested by a sound heard from a bath tub, to the metallic lining of which one of the terminals of the secondary wire was attached. This sound was heard when the dry hand, grasping the other terminal, was slid over the lining. Gray experimented at considerable length on this curious observation, and soon found that a receiver of this character was able to reproduce sounds of varying pitch, so that a tune played at the distant end of the line was distinctly reproduced by the receiver.

In order to readily obtain the continuous sliding motion necessary in this form of receiver, Mr. Gray mounted a thin, cylindrical, resonant box of wood on a horizontal axis; on the cylindrical surface of the box was placed a slightly convex, metal cap. The metal cap was connected to the ground by means of a wire. When the end of the line was held in the hand and the fingers were pressed against the metal cap, musical sounds made at the distant end of the line were distinctly heard when the cylinder was revolved. When the current passing is sufficiently great, these sounds are readily heard at some distance from the receiver. Within certain limits they increase in loudness when the crank is turned more rapidly.

Gray did not appear at first to understand the manner in which these receivers operated. Later, however, he attributed them to the slipping of the hand on the metallic surface due to the variations in friction produced by the current. He noticed an increase in the friction whenever the key was closed. This principle, it will be observed, is quite similar to the principle employed by Mr. Edison in his motograph.

Gray patented this form of receiver in connection with a telephonic transmitter that was able to transmit articulate speech, in 1878. He obtained the necessary electro-motive force of the electrical currents requisite for the successful operation of the receiver by the use of an induction coil. He points out in his patent the fact that other animal tissues may be employed in the place of the fingers of the hand. In this application the receiver is figured as a highly polished metallic disc of thin sheet metal, mounted on a resonant box or case, provided with a shaft so as to be readily revolved.

An exceedingly simple, yet quite efficient receiver is shown in Fig. 5.

In this form, an iron vessel, supported as shown, is firmly fixed in an upright position by one of its edges. An electro-magnet, separately mounted on the same base, has its

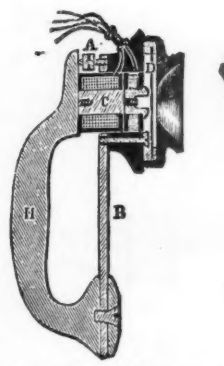


Fig. 8.—Gray's Electro-Magnetic Telephone (Section).

Fig. 7.—Gray's Duplex-Bi-Polar Telephone.

Fig. 9.—Gray's Electro-Magnetic Telephone (Elevation).

poles near, but not in contact with the bottom of the pan. Under these circumstances the bottom of the pan acts as a magnetic diaphragm, and emits musical or other sounds, uttered at the other end of the line, with great distinctness

The resemblance of this form of receiver with that now employed in the articulating telephone is too evident to need comment. It will speak quite plainly when placed in connection with any form of articulating transmitter, such for example as that figured in the Gray caveat, or with a Reis transmitter. Indeed two such instruments placed at the extremities of a circuit in which is included a battery, form a complete telephonic system, since one of them can be used as a transmitter, while the other will act as a receiver.

Although these receiving instruments were not used by Gray to receive articulate speech prior to the actual use by Bell of his form of articulating telephone, yet they are of interest when taken in connection with the actual position that Gray occupied as regards the articulating telephone as exhibited by the description contained in his caveat of February 14, 1876. In that paper he clearly expresses the objects of his invention as being means for varying an electric current by the human voice for the purpose of throwing on a telegraph line such variations as will, when suitably received at the distant end of the line, reproduce the voice. He figures a form of transmitting instrument that will so permit the voice to vary the current of a voltaic battery and a form of receiver that will act in connection therewith. He is operating with a current that is greatly varied, and contrives for its reception a receiver that is capable of responding to a wide range of variations. Since then the receiver shown in Fig. 5, was devised for exactly the same purpose, he is, it would seem, to be entitled to use it to replace the receiver shown in his caveat already referred to.

On the 29th of October, 1877, Gray filed a number of applications for letters patent, viz.: one for the "art of transmitting vocal sounds telegraphically," one for "certain new and useful improvements in apparatus for transmitting vocal sounds telegraphically," and one for "certain new and useful improvements in electric telephony." In the latter application he figures substantially the telephone receiver, which is shown in connection with Fig. 5. This he styles his "concave diaphragm receiver," for speaking telephones. His application shows similar instruments at each end of the line, for receiving and transmitting instruments respectively.

Gray has added a number of important features to the articulating telephone as it is to-day commercially employed. He took out a number of patents in 1878. Among other instruments he devised a method by means of which the weakening effects on the electric currents transmitting articulate speech, due to their passage through a number of instruments, calls, etc, placed in series in the main line, were decreased. This method consisted essentially in the use of condensers.

In the same year he invented a contrivance by means of which all sounds not transmitted through the line wire are excluded from the observer's ear. This he effected by mounting two telephones on a common support so that they could readily be simultaneously applied to both ears of the person receiving the message. The two telephones were mounted on rocking bearings so as readily to adapt themselves to the ear of the listener. At the same time the handle of the common support, on which they were mounted, was made so as to readily be grasped in one hand, thus leaving the other hand free to hold an ordinary transmitting instrument to the mouth, when it was desired to send a message.

Gray invented his bi-polar telephone, shown in Fig. 6, in 1878. In this instrment, as the name indicates, there are two magnet poles, each of which is caused to act on a separate metallic diaphragm, inclined at such an angle with respect to each other as to permit the use of a single mouth-piece placed between them. A permanent magnet, U-shaped, serving as the handle of the instrument, has two electro-magnets secured to its two poles. The soft iron cores of these magnets are provided with the usual coils of insulated wire. The cores are attached to the permanent magnet by securing them into ends thereof, so that they are thus readily adjusted with respect to the iron diaphragms, of the usual construction, placed opposite them.

In the same year Gray extended the idea contained in his bi-polar telephone, and constructed a device which he termed his "duplex bi-polar telephone." The object of this instrument is to increase the volume and clearness of the sound. This he endeavored to secure by the combination with a common mouth-piece, of a series of diaphragms with their corresponding magnets "arranged in pairs on the outer, opposite, sides of the poles of a permanent magnet and in a reverse order relatively thereto, in such a manner that the secondary diaphragms and the magnet of each pole will be actuated directly from or by its primary diaphragm."

Gray has produced a number of modifications of his bi-polar instrument. Besides the duplex bi-polar telephone above described, he patented, in 1878, another modification intended to increase the electro-motive force of the generated current, and to obtain an increased volume and clearness of the sound produced. In one form he shows a bi-polar telephone "with its diaphragms and electro-magnets duplicated, and arranged in reverse orders on each side of the poles of its permanent magnet. The soft iron core of the electro-magnet is made tubular. Through this core a light rod of wood or other non-magnetic material passes. The ends of this rod are rigidly attached to the centers of both diaphragms, so that the movement of either of the diaphragms produces corresponding movements in the other diaphragm. By this arrangement the inventor is enabled to vibrate two diaphragms before two electro-magnets, both of which receive their magnetic charge from the same pole of the permanent magnet. The other pole of the permanent magnet has similar apparatus connected with it, so that the inventor thus obtains the current produced by the vibrations of four separate diaphragms.

This form of telephone is shown in Fig. 7. The U shaped steel magnet is seen at *A*. The tubular soft iron core, *D*, is provided with helices, *C*, *C*^{1}, and diaphragms, *E*, *E*^{1}. The rod *d*^{1}, intended to carry the motion of the diaphragm nearest the mouth to the other diaphragm, is connected to the two diaphragms as shown. On the left hand side of the drawing similar parts are shown in elevation.

In Fig. 8 is shown Gray's electro-magnetic telephone. This instrument consists of a handle, *H*, of iron or steel, furnished with a soft iron core, *C*, connected by means of a screw with one end of *H* in the manner shown. This core is wrapped with a coil of wire of comparatively low resistance that is included in the circuit of a voltaic battery of two or three cells. Opposite to the core of this magnet, and mounted thereon in the same plane, but separated therefrom by some non-magnetic material, is placed a second electro-magnet. The core of this magnet is made of a slotted tube of soft iron. The coil of wire wrapped thereon is made of a much higher resistance than the coil in the first magnet. A stiff spring-plate, *B*, of iron or steel is secured at one end to the handle, *H*, and at the other end is perforated so as to permit the magnet core, *C*, and its coil to pass through it. This metallic plate is securely attached at its upper edge to the edges of the magnetic diaphragm. In this manner, as will be seen, the opposite poles of the magnet are brought into close proximity with each other, and their magnetic effects greatly increased.

The idea of thus connecting the diaphragm with the opposite pole of the magnet has been employed in a number of different telephones.

In Fig. 9 is shown the elevation of this form of speaking telephone.

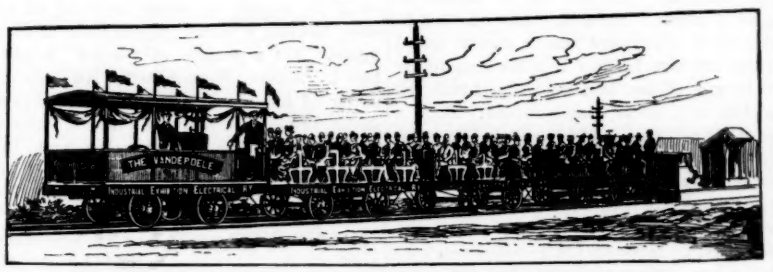
The Kerite Underground System in Chicago.

The Day's Kerite Underground System of the Bankers and Merchants' Telegraph Company of Chicago, comprising nearly twelve miles of conduit and two hundred miles of wire is the most extensive undertaking of its kind in this country. It was commenced on April 23d of this year, and on August 23d was fully completed and in thorough working order. Much time was lost in moving the gangs of workmen from place to place, as the line runs in many cases upon streets that were to be permanently paved with Belgian blocks, and the work had to be done without interfering with the city contractors.

Starting from the company's main office, at 144 E. Madison St., the main line runs east

on Madison St. to Clark, south on Clark to 22d Street, west on 22d Street to Lasalle, south on Lasalle to 39th Street (the city limit), and west on 39th Street three blocks to the pole line, its length being four and one half miles. From this line branches start at various points and run to and through the business parts of the city, to all the leading hotels and into the centers of mercantile interests. On South Water Street, among the commission men, on Rush Street, where the tobacco trade is located, on Wabash and Michigan Avenues, among the wholesale grocers, and on Madison Street, with the dry goods trade. The old and new Boards of Trade, and the Open Board have lines run to them. The exposition building has its branch, and during the conventions in June and July all the press business and specials handled by the company were worked through it. The main line is constructed of 4″ cast-iron pipe, weighing 17 pounds to the foot, with joints caulked with oakum and lead. At the intersections of streets, circular manholes, with heavy iron covers, are built, and and in these the connections are made with the branch lines. The branch lines are of 2″ and 3″ pipe, laid in the same way as the main line, with similar manholes at street intersections. From the main office to the corner of Clark and Madison Streets, where the main line runs south, seventy-nine wires are run through the 4″ pipe. At Clark St., 50 of these wires run south, and 29 north. At Jackson Street [illegible] wires are divided, 20 running south, 20 west, and 10 east. These last 10 again divide at Wabash Avenue, four of them continuing east, and six running north. In this way the cables gradually grow smaller as the extreme ends of the branches are reached. The cables for the entire service are Day's Kerite, with No. 15 B. W. G. Conductors, insulated to $\frac{8}{32}$ of an inch. From first to last these cables have worked perfectly, no trouble of any kind having been experienced with them; they have required no attention whatever, and the services of repair-men are entirely dispensed with. The first cables were put in in the early part of May, and when tested in August by Dr. W. W. Jacques, of Boston (who visited Chicago in the interest of the American Bell Telephone Company to examine into the merits of the conduits and cables), showed a very low static capacity, 0.07 to 0.08 micro farads per mile, and with resistance of insulation of over 1,000 megohms per mile. At the same time practical telephonic tests were made, conversation being carried on through twelve miles of the underground wire on both ground and metallic circuits. Long pole lines, notably one from Michigan City, 80 miles distant, was connected with the twelve miles of underground wire and a conversation was held between the two offices without difficulty or trouble. The results of these tests were highly satisfactory. The construction of the conduit and the running of the cables was effected without any accident or trouble of any kind apart from engineering difficulties, and those arose principally from the fact that the city authorities would not allow the streets that were permanently paved with Belgian blocks to be disturbed, causing, in one instance, a great divergence from a direct route; and in another case, caused a part of the line to run through a basement engine-room, then across the face of the abutment of a bridge, under a freight gangway, through several hundred feet of sidewalk, and finally through half a dozen basements before street line was again reached. During the work the tenants and property holders along the line gave every encouragement to the enterprise, and seemed pleased to find that there was to be increased ample telegraphic facilities in their immediate vicinities without the usual annoyance of either pole or housetop wires. In a letter received a few days ago from the repairman whose duty it is to look after the underground line, he says: "I am working in the battery-room, and I only go over the line once in two weeks; but there has been no trouble on the cables." In addition to the Kerite cables in this system, Prof. John P. Barrett, the Superintendent of the Chicago Fire Alarm and Telegraph service, has put underground during the year about 100 miles of kerite wire, and all the lines of the police and fire department running to the general office in the new city hall are under ground, and give entire satisfaction. In 1875 he put down some iron pipes on Lasalle Avenue and ran kerite wire through them, and in answer to a very recent inquiry, he says: "The wires I put down in 1875 have never cost one cent for repairs, and are working as satisfactorily to-day as the day they were laid."

The Postal Telegraph Company have a hundred miles or more of underground wire also laid in the city, making in the neighborhood of 500 miles of conductors in daily actual use, proving most conclusively that underground telegraphy is not only practical but economical, as the services of line repairmen are dispensed with, and there is no loss of time by poles blowing down from summer storms, or by heavy snow and sleet in the winter season. The credit of making such a success of the extensive underground lines of the Bankers and Merchants' is due to Mr. Clark B. Hotchkiss, the general agent for Day's Kerite, who was seconded by Mr. E. B. McClees, who had charge of the practical details, neither of whom spared time, trouble, or thought to make the undertaking what it is, a thoroughly reliable, practical, and economical system of underground telegraphy. Mr. Hotchkiss has added to his already extensive business in the manufacture of insulated wires and cables, the building of underground telegraph and telephone lines, and will furnish estimates for the construction of conduits, and wire and connections complete.



THE VAN DEPOELE ELECTRIC RAILWAY, TORONTO, ONT.

—— An electric current, capable of maintaining distinct groups of lamps, has been transmitted from Turin to Lanzo, a distance of forty kilometers, or twenty-five miles. Gaulard and Gibbs' secondary generators, with two three millimeter bronze wires (one for return), were used, and the experiment is said to have been perfectly successful, giving an efficiency of 89 per cent.

The Van Depoele Electric Railway at Toronto, Ont.

An illustration of this system of electric railways as used at the Annual Fair at Toronto, will be found herewith. As we have described the special features of this system before, we will only add that the locomotive car containing the electric motor and appliances weighs about seven tons, and occupies a space of six by fourteen feet. The motor is of the type of the standard dynamos manufactured by the Van Depoele Electric Light Company, of Chicago, Ill., and the power available is about thirty horse-power. The electric current was generated in the Machinery Hall Building, where a steam engine is running a forty horse-power generator of the same type as the motor. The current from the generator was conveyed by means of two copper conductors from the generator to two flat copper strips running the whole length of the track, some 2,000 feet. These copper strips are carried in a base made of well-seasoned lumber, thoroughly permeated with insulating gums. The insulation leaves nothing to be desired. Upon these two strips two brushes are traveling with the car, carrying the current to the switches and motor. The whole arrangement is complete in every detail. The cars can be run backward and forward with perfect ease, and fast or slow as desired. The track, as above stated, is some 2,000 feet in length, and has for a distance of 1,000 feet an incline of from one-eighth to three-sixteenths of an inch to the foot; there are also four curves; the track is straight and level at each end. As at present, the motor car pulls three cars each of three tons weight empty. Each car can carry sixty people or more.

Copper Mines and the Copper Trade.

The leading copper property of the East is that known as the "Betts Cove" Mine, in Newfoundland. This mine produces very large quantities of low grade copper sulphurets which are shipped direct to Swansea. They employ some 600 miners and have their own church and schools. The Company are obliged to carry a very large stock of supplies, being cut off from the market several months of the year. The average value is $250,000. In buildings and plant over ground the values are estimated at one million The ores are low grade 2½ per cent. to 3½ per cent. Yet Mr. Ellerhausen, the Manager and part owner, states that the large yield pays very handsome dividends.

The Coxheath Mine, near Sydney, Cape Breton, is also copper sulphurets, carrying some silver. This mine is principally owned and controlled in Boston; the ores vary from 3½ per cent. to 27 per cent. A large amount of money has been expended in opening and developing this mine, and a large amount of ore raised, and it is understood that their market is Swansea.

The Province of New Brunswick is also very rich in copper ores as well as other valuable minerals The counties of St. John, Kings, Albert and Westmoreland, all have deposits of copper. The latter, however, is probably the richest, and covers a large area between Dorchester and Sackville. The ores of this district are chalcocyte or copper glance, and are found in the sand rock of the lower carboniferous formation. They lie in stratas, one above the other, varying in thickness from four to ten feet, and dip to the south-east. The ores assay from 2½ per cent. to 76 per cent., but will average about 10 per cent. This district was hardly known four years since, but it is now being worked to a limited extent, and very successfully, and is the cheapest mining district known. Lumber, fuel, labor, and living, are very low, and being at the head of Chegnecto Bay, has water communication with the world, and by the Intercolonial Railway to any portion of the Dominion or the United States.

The ores of these mines are sought for by smelters on account of the silica they contain, and are used by smelters in Swansea to mix with low grade sulphuret ores.

The Colonial Copper Mining Company have erected substantial buildings and put in good machinery, and started some ten months since to develop their property with a view of determining, first, what kind of plant was necessary to erect to work the ores successfully; second, to prove the quantity of ore sufficient to warrant the erection of suitable plant; and their ten months' work has proved that the ore bodies are practically inexhaustible, and that the ores can be mined, raised, crushed, and concentrated at less than two dollars per ton. New Brunswick will soon come to the front as the cheapest copper producing district on the continent.

A little American capital would soon develop Westmoreland county into a rich and prosperous mining county.

Only 32 hours from New York by rail, capitalists can work these properties under their own supervision.

Previous to 1882 the copper trade was ruled in the most despotic manner by the lake companies, among which in turn the Calumet and Hecla Company, by its exceptional position, had the undisputed leadership. Secure in their position, the lake companies looked with disdain upon the efforts made in other parts of the country to develop copper mines, and it was only in the spring of 1883, when all the old methods had failed to maintain prices, that they began to appreciate the fact that their absolute power was gone forever. How completely and how rapidly the development of the Western mines changed the conditions affecting the industry may be gathered readily from the following statistics of production. In 1880, the output of copper in the United States was estimated at 27,000 net tons, of which the lake companies contributed 22,204 tons, or 82 per cent. of the total. In 1881, the figures were respectively 32,000 and 24,363 net tons, and 76 per cent. In 1882, they stood 40,912 and 25,439 tons, and 62 per cent., and in 1883, 58,000 and 30,000 net tons and 52 per cent. This year, according to estimates made on the basis of the known output of a large number of mines for ten months, the production is likely to be 70,000 net tons, of which the Lake Superior districts will furnish about 34,000 net tons of ingot, or less than 50 per cent. In spite of the fact, therefore, that during these five years the production of the lake mines increased from 22,000 to 34,000 tons of copper, or 55 per cent., their proportion of the aggregate in the whole country has dropped from 82 to 50 per cent.

This enormous increase in the yield of our mines is due to a variety of causes, among which the attention directed to the mining of that metal in the Rocky Mountains may be insisted upon as the leading one. Beginning with the developments in Arizona, there are a number of large mines like the Copper Queen, Old Dominion, Arizona, United Verde, and Detroit, working oxidized high-grade ores, which in the aggregate, with a number of smaller concerns, do not make less than 12,000 tons. Arizona has, however, been outstripped now by far by a small group of mines near Butte City, Montana, whose production will this year reach, if it does not surpass, 20,000 tons, the principal concerns being the Anaconda, Montana, Parrot, Bell, Gagnon, and others. Some of the ores carry highly remunerative quantities of silver, while others are too low in that precious metal to admit of its being extracted with profit.

Besides this, copper in smaller quantities is turned out in New Mexico, California, Nevada, Utah, Colorado, Wyoming, and Missouri, the output of the Atlantic States having dwindled to an insignificant figure.

The effect of this enormous increase in the production has been a rapid lowering in the prices not alone at home, but also abroad, where the arrival of large quantities of ore, matte, black copper, and ingot has effectually defeated any attempts to lift prices. It has forced our copper producers to become exporters of copper in every form, from the ore to the ingot, and has put them into the position of competing fiercely in the open markets of the world with all the great copper-producing countries in Europe, Africa, South America and Australia, which thus far have supplied them. Coming as the copper does from so many sources in this country, with so many and such varied interests involved, the days of combinations to hold up our home markets permanently above those of the outside world have ceased. The managers of the leading concerns in this country fully understand what a fierce battle they are engaged in with the accumulated wealth of the copper aristocracy of Chili, the giant pyrites companies of Spain, and the rich mines of the Cape and Australia. They, as well as their foreign competitors, are increasing output and are practising every economy to reduce general expenses and cost. They appreciate the fact that their metal will not fetch more here or elsewhere than the price regulated by the supply and demand. The duty on copper has become a dead letter.

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We extend to manufacturers of electrical apparatus an invitation to send to this office any and all facts concerning their business which will be of interest to the public. We make no charge for publishing news.

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NEW YORK, DECEMBER 13, 1884.

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The Bell Telephone Company has determined to go into long-line telephoning on a large scale, and the hard-drawn copper wire folks will be happy. It is a favorable time for embarking in this enterprise, for copper is away down in price, making a very considerable difference in first cost.

There is a growing disposition among those who buy dynamos and lamps from the electric manufacturing companies to demand that the prices charged shall bear some reasonable proportion to cost of material and manufacture, and that all hampering conditions shall be done away with. A reasonable charge for patents no one objects to, but more than one company is falling behind because it persists in keeping prices at a point which users of electric lighting apparatus cannot afford to pay.

In the "Editorial Notes from Boston," this week, will be found much that is of interest concerning the American Electrical Exhibition opened in that city on Monday of this week. As a matter of course, it was not ready on the opening day, but it has since been put into presentable shape, and is attracting many visitors. It seems to have been the object of the management to secure novel and striking exhibits, and in this they appear to have been successful. Further and more detailed descriptions of the more important exhibits will be given from week to week in the REVIEW.

We this week print nearly the entire text of Judge Wallace's decision in the Drawbaugh case. It is admirably written, clear and concise, and, considering the ground covered, may fairly be called brief. It will be noted by what process of reasoning the judge disposes of the "cloud of witnesses" who attest to the validity of the Drawbaugh claim, and how clearly he brings out the point which gives arise to the "fatal doubt" as to that validity. The strength of the decision, as it seems to us, rests upon the fact that it is based upon a broad general principle—a principle of common sense as well as of law. The claim set up that Drawbaugh was in abject poverty, and could not raise the money necessary to take out a patent, was disproved by documentary evidence and his own admissions; and, when it came to the question why he did not apply for a patent long before Professor Bell was heard of, the conclusion was inevitable that in all probability he had nothing whatever to claim a patent upon. Hence the "fatal doubt" which has lost him his case.

EDITORIAL NOTES FROM BOSTON.

Keep your ears open and you will hear several things "drop" over this way before long. I am pledged to secrecy, and I know that serious and perhaps irreparable injury would be done to "enterprises [electrical] of great pith and moment" by premature disclosure, and hence I hold my peace, but the waters are moving, and you may reasonably look for interesting developments ere long.

Mr. Theodore N. Vail sailed for Europe last Saturday He told me he should be gone a month. He didn't say whether he should be gone *more* than a month, and I didn't ask him, because it didn't seem to me to be any of my business But I fancy he will be back before January is out. He is a hard-worked man, and rest will do him good. It is not probable that he has gone for rest exclusively—I didn't ask him that either—but the passage both ways is a blessed interval in which "no telephone connects" with anybody, no messenger boys haunt you with telegrams, and no mail comes to hand.

Colonel Keller, formerly one of the owners of the telephone franchise in the territory which now constitutes the South-Western Division of the Erie, who has been for two or three months making an inspection, on behalf of the American Bell Telephone Company, of the various exchanges belonging to the New England Telegraph and Telephone Company, has submitted a lengthy report, covering many recommendations. Among these one of the most important is that a number of small exchanges be abolished, and that subscribers to them be connected with the nearest large exchange by means of cables. And it is further recommended that a new and comprehensive system of keeping accounts, somewhat more elaborate than that now in vogue, be adopted by the company. These recommendations have, as I understand it, been approved by the American Bell Company, which means, inasmuch as the A. B. C. owns the control of the N. E., that they are to be put into practice by the latter. When Mr. Downs resigned as general manager of the New England Company, the vacancy was not filled, but the duties of the office were added to those of the vice-president, Mr. W. A. Ingham. In view of the new departure, the result of Colonel Keller's recommendations, it has been thought best to appoint him acting general manager, to give him a chance to put his own recommendations in force—a wise move, under the circumstances, and certainly a great relief to Mr. Ingham, who has been doing double duty.

Colonel Keller is a bright, wide-awake, keen-eyed man, who has had a good deal of experience in the telephone business, is willing and quick to learn, and is *not* carried away with the idea that he "knows it all." He is a genial, pleasant man, certain to make friends, and—what is just as much to his credit—equally certain to make enemies. He will find folks down this way a little different from those in the South West, and a trifle inclined to the opinion that they are also a little *better* than those in the South-West—a very natural mistake, considering their ignorance of the people in the S. W. And he will have to steer with a good deal of care, for, although the soil is mighty shallow in New England, prejudices somehow have very deep roots.

There were rumors a month or two ago to the effect that, if the Bell Company won its suit, an extra dividend would be paid to stockholders out of the surplus which the prudent and conservative policy of the management has caused to accumulate. Well, the rumor has "materialized" in the form of an extra dividend of 3 per cent., making 15 per cent. for the year. Most people supposed that this would give the stock a "boost," but it didn't. Things sometimes work "contrarywise;" showing that you "can't always tell." The offerings of stock increased, and the price fell off, so that on Saturday it was down to 255, twenty points below what it brought immediately after the decision. Folks that bought down along to 150 are not grumbling, but a good many of them, who went in for a rapid rise and a quick turn, are realizing.

There's a new plan afoot. It is to apply to the Massachusetts legislature for permission to increase the capital of the Bell Telephone Company up to twenty million dollars—double the present figure. The Bell Company wants to go into "inter-state" construction on a large scale, and to do it needs money. I don't imagine that it wants to swell its capital to twenty millions all at once, but that it wants the limit set at that figure. Not a particle of "water" is proposed. Under Massachusetts laws, every dollar of new stock issued must represent a dollar, or more, actually paid into the treasury in cash. The issue may be made by giving every stockholder the right to take such a proportion of his present holding in new stock at *par*—in which case his "right" or "privilege" would have an important market value—or it may be made by offering the stock to the highest bidder *above par*, in which case the premium would go to swell the amount in the treasury. This latter is the conservative way *for the company*, but "rights" are very dear to stockholders.

I have been particular to speak of this matter, because I know that the charge will be made that this proposed increase of capital means a watering of the stock. I would bet high that, when the bill authorizing it is before the Massachusetts legislature, some sapient ass will get up and declare from his place in the House or Senate that he is opposed to all stock-watering operations of every name and nature. More than this, I fully expect to read in some one of the more or less "well informed" papers of this metropolis that this is a dangerous measure, inasmuch as it is an effort to inflate the capital stock of the company by injecting wind into it. Now keep your eyes and ears open, and see whether or no I have any gift of prophesy.

I note what our Detroit friends say in their letter in last week's REVIEW about the tower system in vogue in their pleasant city. I was sorry not to stop there on my way East; but time pressed, and I had to come straight through. A friend in Boston, who has just been out there, says the lights present a wonderfully beautiful appearance from Windsor, across the river; but that, in his opinion, for purposes of illumination, the post system is far more effective and economical as to number of lights required. Of course, this is only one man's opinion, but he is something of an expert. My idea is that masts and towers are excellent for open spaces, like Madison and Union Squares in New York, especially if supplemented by a liberal fringe of electric lights round the edges; but I cannot think that any one will seriously maintain that, in a compactly built city, mast illumination, however beautiful it may be, is going to light streets as effectively as the same or even a smaller number of lights placed at proper intervals along the streets on posts not too high.

And this leads me to say that in most cities—Boston being one of them—the electric lights used for lighting the streets are placed higher in the air than need be. The thing to be done is to light the streets—*the ground*, not the *air*—and as long as the lights are high enough to be out of the way, say twelve or fifteen feet, what is the use of going higher? In cities where the wires are carried on poles there is perhaps a good reason for the higher level, but in has no force in Boston, where practically all wires are on housetop structures.

The Electrical Exhibition is open at last. The "opening ceremonies," which had the merit of being short and simple, took place on Monday afternoon at about 5 o'clock, two or three hundred people being present. But later on in the evening the building was thronged, not less than four thousand people being present.

Of course, the Exhibition is not ready. No exhibition on record ever was or will be ready on the opening day. The management at once determined to pursue a liberal policy, and to give every purchaser of a ticket an additional ticket gratuitously, to be used later on. Thus, although many who came felt disappointed to find so few exhibits ready, no one could complain of having been wronged.

And yet things were not so very bad. More exhibits in proportion were in shape than were those that made up the Philadelphia Exhibition, and the promise that there would be more interesting and novel things than at Philadelphia seems destined to be fulfilled. Before this reaches the REVIEW's readers, the Exhibition will be in good shape, and I venture to predict that it will prove very popular and be largely attended. It is an exhibition for the people rather than for electricians. The Philadelphia show was for electrical people mainly, but the electrical people mainly stayed away. It was the great public that filled the building in West Philadelphia and the coffers of the Franklin Institute; but while they saw many wonderful things, they saw but a limited number that interested them specially, and fewer things that they understood.

The Exhibition is not, at the start, specially strong in electric lights. There are thirty arc lights of the Arago pattern run from two disc dynamos. They are doing good service, and I shall have more to say concerning them later on Then there are quite a number of Weston, or United States, arc lamps, run from the company's station on Stanhope Street, and eighteen "Moguls," the name given to the new 125-candle power incandescent light shown first at Philadelphia, to which I have already made allusion in these notes. The Edison folks have four hundred incandescent lights, working beautifully from the word "go." They illuminate the hall, and large "electroliers," carrying a very large number of these lamps, hung over the Bell Telephone and Western Electric exhibit, throwing a perfect flood of soft light upon them. The "Consolidated" is getting into shape, and will soon have some lamps in operation. It is said that the Brush folks are "coming right along" with both arcs and incandescents. They will miss it if they don't. They were terribly backward in Philadelphia, but when they got fairly started they made a fine display.

The Thomson-Houston people, who made one of the most attractive and well-arranged exhibits in Philadelphia—complete, compact and comprehensive, without any splurge—will not, it is said, exhibit. They know their own business best, of course, but to my mind it is a mistake. So far New England has been the Thomson-Houston Company's best field; they have a light whose excellence is everywhere admitted, and a local prestige

which they naturally want to preserve and strengthen. Of course, their conspicuous absence from this Exhibition does not affect the quality of their light, but people will assign reasons and—all know the proverb, "the absent are always wrong."

The Bell Telephone Company has done the handsome thing, and done it well. Mr. Gilliland has it in charge. It is made jointly with the exhibit made by the We-tern Electric Company, and is, like the latter, substantially the same as was shown in Philadelphia. But there is to be a "popular" feature not shown in the Quaker City. The "copper line" to New York has been extended to the exhibition building, and Mr. Edison has furnished a "motorphone," or loud-speaking telephone, so that conversation in New York can be heard in Boston by a large number of persons at once. During the evenings, microphones, placed in the Grand Opera House in New York, are to be connected with this line, and the orchestral and vocal music there produced will be reproduced here by the motorphone, so that quite a Boston audience can "assist" at the performance.

By the way, a clever scheme of somebody's has been ingeniously and nicely carried out. The stage and proscenium of the Bijou Theatre have been reproduced in miniature, the curtain line being about five feet. There is a set scene, lighted by miniature incandescents supplied by Mr. Edison, and on the stage, properly screened, a motorphone will be placed. The whole will be connected by special wire with the Bijou Theatre, and every evening audiences will assemble in front of this little theatre and hear what is going on in its prototype, more than a mile away. Do electricians turn up their noses and call it "sensational?" Perhaps it is, but it is calculated to interest, please, and instruct *the public*. What else are public exhibitions for?

The Bidwell electric railway is in working order and attracts much attention. It has risen to the dignity of a train, viz., a car carrying a Weston motor, with accommodations for passengers, and another for passengers exclusively. The motor is connected with the wheels by means of a belt, a temporary and not wholly satisfactory device. The track runs entirely around the gallery. The method of taking the current from two conductors running parallel with the track was fully explained in my notes from Philadelphia. The same current lights the cars by incandescents, and, if neccssary, the track by means of arcs. The current in this case came from the Stanhope Street station of the Weston Company. Mr. Bidwell tells me that he already has applications from several places where it is desired to replace horses with electricity, and also that he has worked out a complete system of switching. On surface roads the conductors would not be as shown here, but in underground conduits, similar to those used on the cable roads, though materially smaller. Connection would be had by means of a slot such as the "grip" passes through on cable roads, but only one slot would be necessary, as the connections could easily be made "tandem." I am promised much more elaborate and explicit information on this subject as soon as the hurry and worry incident to getting the road into thorough working order is over.

The "cable station" is a most interesting place to all visitors. At the Philadelphia show there were no end of reflecting galvanometers, but I saw none in operation. Here we have a dark room in which, upon the two ends of a long table, are two reflecting galvanometers, with lamps and reflectors complete, and small screens upon which the movdments of the spot of light, influenced by the change in the current, can be distinctly seen. The gentleman in charge tells me that he hopes soon to have a Thomson syphone recorder in operation, so as to show the new as well as the old way of transmitting intelligence by cable. Whole volumes would not do as much to teach the public how this is accomplished as this very modest "station" and the apparatus which it contains.

So far there is not much in the battery line, but I understand that quite a variety of batteries will be shown. There is good and important work to be done along this line, and a number of bright men are at work upon it. The greater part of them are content to simply modify old forms, and very few seem to have the courage to strike out boldly into new fields. There's a big prize in this direction somewhere, and somebody's going to find it some day.

Mr. Edison's private exhibit has arrived, and will be arranged before the week closes. It is essentially the same as was shown at Philadelphia, and is eagerly looked forward to by people here. Mr. Edison himself is expected over this way, and I have no doubt that his exhibits will be much enlarged and improved after he has got into the spirit of the thing. That is his way. Over in Philadelphia, as soon as he took a hand personally, things began to "hum."

There has been a municipal election here this week, which has a certain interest to electrical people. The candidates were the present Mayor, General Martin, a most estimable gentleman, and as honest a man as lives. On the other side was Mr. O'Brien, treasurer of the local Brush Electric Light Company, who had done the city good service as an alderman, and is deservedly esteemed. He has been something of a partizan, but no one has ever whispered one word against his integrity or questioned his ability. In his inaugural address, General Martin sat down hard on electric lights. He showed complete but honest ignorance of the subject, and during his term he has been the unconscious and unintentional tool of the Boston Gas-Light Company, as unscrupulous a monopoly as ever lorded over a suffering people. Mayor Martin heard something "drop" on Tuesday, for he was "snowed under," and Mr. O'Brien succeeds to his place. Everybody respects General Martin, but the majority seem to have no further use for him as Mayor. Not only the electric light companies, but all the companies having wires have had to put up with constant and unnecessary annoyances from City Hall during the past year. It will be a trifle different after the new year comes in. The fact is that the people want electric lights and all other electrical conveniences, and the outcry against the wires, a necessary evil, has not come from them, but has been "inspired" by interested parties, of whom the gas people have not by any means been the least. Of course, the electrical companies have had no hand in Martin's defeat—of course not. Of course, it is very distasteful to them—*of course, it is!*

Of Interest to Inventors.

At the last meeting of the American Society of Mechanical Engineers, Mr. Oberlin Smith introduced a very interesting and important subject, to wit, the delays in transacting business in the Patent Office, and the injury incurred thereby to all and sundry. Much discussion ensued, resulting in the appended resolution:

"*Resolved*, That in furtherance of the views of the society on the important subject of protection by patents, as expressed in the discussion thereon during the present session, the President be, and is hereby requested to embody said views in a memorial to Congress, to be prepared by him and such other members, if any, as he may request to co-operate with him therein, which memorial shall be duly forwarded to Congress on or before the date of its assembling next month; that said memorial shall recite briefly the importance of the interests involved, the fact that the patent system is based upon a recognition of the rights of the inventor to the value of his work; that the fees were merely to cover the cost of conducting the same; that already some $3,000,000 have been collected from inventors in excess of such cost, and that the reason of the diversion of this large sum from its legitimate purpose — the work of the Patent Office, through the resulting inadequacy of its clerical force—is and has long been greatly in arrear; and, finally, as an inevitable consequence, inventors are subjected to unreasonable and in many cases disastrous delays in obtaining the protection to which they are justly entitled, and for which they are charged; that said memorial shall be so presented as, if possible, to secure for it favorable and early consideration.

"Further, that to the same end the President shall cause to be prepared a suitable power of petition embodying substantially the same arguments, and shall cause a copy thereof to be forwarded to every member of the society, with the request that, if approved, each member will sign the same, and will procure other signatures thereto, and will thereupon promptly transmit to his member of Congress or senators, with his personal request that the measures advocated in the memorial may have his support and advocacy."

The Dominion Government of Canada having so far turned a deaf ear to the suggestion that it should establish a complete national telegraphic system, the Toronto *World* now comes forward with a good word in favor of the telephone as a substitute. On this point it says: "The Government should undertake the construction and carrying on of a thoroughly efficient system of telephony. It could be done profitably. The telephone is becoming daily of more general use, and the absence of private monopoly or antagonistic interests would still further conduce to increasing its lucrativeness. Without doubt a Government telephonic service, like the postal service, the telegraph service in England, and the State railways in Germany, would soon add an appreciable sum to the public revenues. If such is to be the proper future of the telephone, however, the sooner the State makes itself possessed of it the better, while as yet the plant and the price for prospective profits are inexpensive." If there is any doubt as to the originator of the idea of a Government telegraphic system the *World* is indisputably first in the field with this its very original successor and proposed substitute The early adoption of this suggestion would at all events have the result of putting an end to the dreadful war now raging between the rival telephone companies, but the public would naturally look to some advantages on its own side a good deal beyond that.—*The Shareholder.*

—— Electric lighting still continues active and furnishes a large amount of business to engine builders. Among a number of minor sales to private parties, the Westinghouse Machine Company report the following recent sales of their automatic engines to corporations: The Lincoln Electric Light Company, of Lincoln, Neb., two engines of 60 horse-power each; the United States Illuminating Company, of Charleston, S. C., five engines of 60 horse-power each; the Toledo Electric Light Company, Toledo, O., one 60 horse power engine; the Hastings Electric Light Company, of Hastings, Neb., two 35 horse-power engines; the Thompson-Houston Company, of Quincy, Ill., three 60 horse-power engines; the Central Electric Light Company, of Chicago, three engines of 45 horse-power each. The Thompson-Houston Company of Philadelphia, are also putting a 60 horse-power automatic engine into their shops and test room.

Edison has discovered during his experiments that an explosion of terrible force can be obtained by introducing a platinum wire into each end of a hollow space like a glass globe, half filled with water, and attaching a dynamo machine. The electricity decomposes the water, which flashes into gas just as nitro-glycerine does. The explosive can, of course, be handled with perfect safety, and is cheap enough; but Mr. Edison thinks the application of some of his new discoveries in electricity to industrial uses of much more importance to the world.

ELGIN ELECTRIC LIGHT COMPANY,
ELGIN, ILL., Dec. 4, 1884.

Editors Electrical Review:

DEAR SIRS:—On my return from Minnesota I found your esteemed favor of 3rd inst., and for your kindly expressions therein contained I am exceedingly obliged, and believe I can fully appreciate the personal compliment. It is true that I have labored earnestly, not to bring any additional light into the world, because it is all here, but simply to demonstrate to the people how to properly diffuse it in order that we may get the best possible results from the smallest outlay of means. Much time, and an immense amount of means have been really wasted in useless experiments, and were not the electric light intrinsically so meritorious there are many people who would have given up the battle in disgust and retired from the field. It seems to me it would be a very wise and proper thing to do to convene together, at some central point, all of the parties interested in the electric light business for the purposes of a general consultation. All the interests opposing electric light are combining together with all the force and means at their demand to resist the introduction and utilization of this great force which cannot be analyzed by the chemist, dissected by the surgeon, weighed up by the grocer, or sold by the yard by any merchant. What we want is an active, intelligent, economical system adopted for the information of the general public, and by meeting together discussing the difficulties that have been, and are to be overcome, I believe would produce excellent results. Think it over and let me hear from you.

Yours very truly,

GEORGE S. BOWEN.

[Mr. Bowen's suggestions regarding a convention of those interested in this great pursuit for mutual discussion and action upon the points alluded to is excellent, and we trust will be favorably considered by all in that field at an early day.—ED.]

MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC Machines. Their Construction and Practical Application to Electric Lighting and the Transmission of Power. By Dr. H. Schellen. Translated from the 3rd German Edition by Nathaniel S. Keith and Percy Neymann, Ph. D. With very large Additions and Notes relating to American Machines. By Nathaniel S. Keith. Vol. I. D. Van Nostrand, 23 Murray & 27 Warren sts., New York. 1884.

This work, in the original, is but a compilation from various standard authorities, and presents but little that is new or original, except in the practical application of the idea of, at length, conceding to electro-generators and motors a special sphere due to the extraordinary growth in importance of the subject in the past few years.

The annotations by Mr. Keith, though occasionally superfluous and in places obscure, are, in the main, valuable additions, and bring the subject well up to date.

Quite an interesting chapter is given from the history of the so-called principle of "mutual accumulation"—that of the progressive growth of the electric current from the latent magnetism, so to speak, resident in the electro-magnets of dynamo-electric machines—in which the claims of priority of invention on both sides of the water are quite fully presented.

The subject of dynamometers for the measurement of mechanical energy, in particular, is treated upon at length and with commendable clearness.

The bulk of the volume, however, is devoted to descriptions of magneto and dynamo-electric machines *per se*, and concludes with a presentation of the theory of the dynamo, as formulated from experimental considerations by Frölich and Marcel Deprez, followed by an appendix, giving tables of electrical units, of wire gauge, of the tension and apparent resistance of the light arc of varying length, of the loss of heating and energy of copper wire circuits, of the power of service of the Siemens' dynamo-electric machine, etc., etc.

The mechanical execution of the book is not up to the usual standard of excellence of the publisher as regards its illustrations, orthography, etc.

Whilst we cannot concede to this volume a prominent place in electrical literature, yet, as a convenient collection of data of its kind, it serves a purpose and suggests a more comprehensive and original treatment of the subject.

Telephonic News

*** On the 3d inst. the counsel for the Bell Telephone Company, in its suit against the People's Telephone Company, entered an interlocutory decree in the United States courts, asking for the appointment of a master to determine upon the profits, costs, etc., due the company under the court's recent decision. Judge Wallace appointed United States Commissioner John A. Shields as master.

*** The American Bell Telephone Company has declared an extra cash dividend of 3 per cent. payable December 15. The regular dividend of 3 per cent. is payable January 1, making 15 per cent. for the year. The present capital of the American Bell Company is $10,000,000, of which $9.500,000 is paid in. They now ask for another $10,000,000, making $20,000,000 authorized. The new capital will be issued as required, and is expected to be used in perfecting their long-distance service and increasing its lines and business. Col. J. N. Keller has been appointed Acting General Manager of the New England Telephone Company.

*** The International Telephone Co. has just received a remittance of $2000 (its first) from Caracas and hopes for a regular monthly remittance after February 1st, when construction of the lines to Valencia and Porto Cabello will be finished. The company is earning about $18.0 net per month, and has a debt of $20,000 in round numbers, which it hopes to extinguish in 1885.

*** The decision of Judge Wallace sustaining the validity of "Bell's" patent is of importance to the Tropical company, which has the sole right to export to South America, Central America, and the West Indies, Bell telephones, Blake Transmitters, magneto call bells, and all other patented telephonic instruments, apparatus and supplies under its exclusive contract with the American Bell Telephone Co.; and as permanent injunctions will now speedily issue against all manufacturers who have been attempting to ignore these patents, it is well for exporters to understand that if they wish to avoid all liability for infringement they should apply only to the Tropical American Telephone Company, Limited, at 95 Milk St., Boston, for all telephonic instruments and apparatus for export to their countries.

.... The total length of all the submarine cables of the world now attains to 60,000 geographical miles, or nearly three times the circumference of the earth. Each cable contains, on an average, forty wires; therefore, the estimated length of iron and copper wire so employed is 24,000,000 miles, or ten times the distance between the earth and the moon. There are in existence to-day seventeen submarine cable companies, and four Governments possessing cables beside, viz, France, England, Russia and Italy. France has 12,018 miles of cables in the Mediterranean Sea, and England owns as much in the Indian Ocean. Out of the seventeen companies, eight are established in London, four in New York, and one in Copenhagen.

.... Littlefield, Allison & Co., have brought an action against the Western Union Telegraph Company to recover $2,000, damages alleged to have been sustained through an operator's "bull" in sending a message to New Orleans. The firm, in December, 1882, telegraphed to New Orleans to have a quantity of lemons sent by way of the "Texas Pacific" Railroad, but as their message was wired it was made to read by way of the "Texas Express." The lemons arriving by express instead of as regular railroad freight made a difference in the price when landed here of $1,681.62, which with additional expenses accrued, is the mount sued for.

The Drawbaugh Suit.

We print herewith the text of Judge Wallace's decision in the suit of the American Bell Telephone Company against the People's Telephone Company.

UNITED STATES CIRCUIT COURT,
SOUTHERN DISTRICT OF NEW YORK.

American Bell Tel phone Company against the People's Telephone Company et al.

The suit is brought to enjoin the defendants from using, and furnishing to others for use, the several inventions described in two patents granted to Alexander Graham Bell, of Salem, Massachusetts, being No. 174,465, bearing date March 7, 1876, for "Improvements in Telegraphy," and No. 186,787, bearing date January 30, 1877, for "Improvements in Electric Telephony." The issues made by the pleadings are practically resolved into the single question, to which the proofs and arguments of counsel are mainly addressed, whether the patentee Bell, or Daniel Drawbaugh, of Milltown, in Cumberland County, Pennsylvania, was the first inventor of the electric speaking telephone.

Concededly, Bell was an original inventor of the telephone, the principles of which, with the essential means for its application, are described in his first patent, and of the improved apparatus described in his second patent. The fifth claim of the first patent is for "the method and apparatus for transmitting vocal or other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds substantially as set forth." This patent has been judicially construed in two cases in the Massachusetts Circuit; and in both casess it was substantially held that Bell was the discoverer of the new art of transmitting speech by electricity, and the claim should receive the broadest interpretation to secure to the inventor not the abstract right of sending sounds by telegraph, without regard to means, but all means and processes described which are essential to the application of the principle. American Bell Telephone Co. *vs.* Spencer, 8 Fed. Rep., 509. Same *vs.* Dolbear, 5 Fed. Rep., 448.

In view of the conclusion reached upon the merits of the case, it is not material whether Bell's inceptive invention did or did not antedate the time of filing his application for the first patent. That application was filed February 14, 1876. It describes apparatus which was an articulating telephone, whether Bell knew it or not. Mr. Cross, an expert, caused apparatus to be made in conformity to the descriptions and to drawings, as shown in Fig. 7 of the patent, which proved itself to be an operative, practical telephone. Probably the date of his inceptive invention might be carried back to July, 1875; but, irrespective of the time of the invention, the justice of his claim to be an original inventor of the telephone must remain unchallenged. It was through him also that the telephone was made known to the scientific public, and thence introduced into commercial use.

The defendants contend that long before Bell had perfected his invention, and long before its mental conception by him, Drawbaugh had not only made the same invention, but had perfected improvements in organization and detail which Bell has never reached, and which were only reached years afterward by the work of many other inventors in the same field of improvement. Their theory of the facts is stated with substantial accuracy in the answer to the bill of complaint. The answer, among other things, avers that Drawbaugh was and is the original and first inventor and discoverer of the art of communicating articulate speech beyond distant places by voltaic and magneto electricity, and of the construction and operation of machines and instruments for carrying such art into practice; that the said electric speaking telephones so constructed, and successfully and practically used by him, contained all the material and substantial parts and inventions patented in the two patents granted to Bell, and also contained other important and valuable inventions in electric and magneto telegraphy; that some of the original machines and instruments invented, made, used and exhibited to many others long prior to the alleged inventions of Bell are still in existence, and capable of successful practical operation and use, and are identified by a large number of persons who personally tested and used, and know of their practical operation and use in the years 1870, 1871, 1872, 1873, 1874, and both subsequently and prior thereto; that said Drawbaugh, for more than ten years prior to 1880 was miserably poor, in debt, with a large and helpless family dependent upon his daily labor for support, and was from such cause alone utterly unable to patent his said invention or caveat it, or manufacture and introduce it upon the market; and that said Drawbaugh never abandoned his invention nor acknowledged the claims of any other person thereto, but always persisted in his claim to it, and intended to patent it as soon as he could obtain the necessary pecuniary means therefor.

Drawbaugh, in his testimony, adopts the statements of the answer as true. He also testifies that he commenced his experiments with the electric telephone as early as 1866; that prior to or as early as in 1867 he had made apparatus (in which he employed a tea-cup as the body of the instrument), through which speech could be transmitted feebly and incoherently; and that as early as the birth of his son Charles he had so progressed that his wife, who was then confined to her bed, could, by listening with one of his instruments, hear the words spoken by him in the other instrument in a distant part of the house. His son Charles was born in 1870, and, if Drawbaugh's narrative is true, he had succeeded at that time in transmitting speech distinctly through his instruments, although whispered words could not be distinctly heard. He describes instruments which he says were made by him from time to time as experiments led him from one improvement to another. He testifies that he thinks he made his first telephone apparatus prior to November, 1866, and is positive he had it before he moved his shop to the "Clover mill" in 1867. As he describes it, the body of the transmitter was a porcelain tea-cup, the diaphragm was of membrane, the electrodes interposed in the circuit were copper, with the upper one connected to the diaphragm by a wire, so as to vary the pressure of a conductor of fine earth or pulverized charcoal through the action of the sound waves, and the receiver was a tin can without a top or bottom, having a membrane diaphragm stretched over one end connected by a tense cord to an armature supported on a spring, and arranged close to the poles of an electro-magnet in the electric circuit. He testifies that subsequently he constructed apparatus upon the same general principle, with some change of detail, and he produces Exhibits "F" and "B," the former a transmitter and the latter a receiver, as the remnants of the original instruments. Exhibit "F" is a glass tumbler; and he states that at first he used a membrane diaphragm over it, and then one of thin metal, and that for the conductor he used carbons, or carbons mixed with bronze powder, and used various tops or mouthpieces to speak into it. The Exhibit "B," he says, was the receiver, and in this he had discarded the string and the spring of his earlier receiver. He says that experiment led him to improve the transmitter "F" by substituting a metal diaphragm in place of membrane, and he produces a sketch. A reproduction of this instrument has been made by him for use in the proofs, "which is designated as Exhibit 'F' reproduced." In this the mouthpiece is modified in size and in distance from the diaphragm. He made, according to his testimony, a new receiver of more perfect construction, and produces the remnant of the original, which is designated Exhibit "C." As he describes the instrument, it was a decided advance upon the former receiver. In using this, he says he tested it also as a transmitter with some success, and then improved it by placing a permanent magnet against the heel of the electro-magnet, and thus made a magnetic telephone. A reproduction of such an instrument as he describes is made and referred to in the proofs as "Exhibit reproduced C." After Exhibit "C" he produces "I," "A," "E" and "D," as likewise original instruments, made respectively in the chronological order of their production as exhibits. He states that "I" was used by him as a companion instrument to "C." Exhibit "A" discloses a modification of form and a higher degree of mechanical adaptation. The last two, "D" and "E," are concededly perfect, practical instruments, and according to the testimony of Mr. Benjamin, an expert witness for the defendants, would compete successfully for public patronage with any magneto telephone which had been introduced into use in 1882. It is asserted of these instruments by counsel that no higher development of the telephone has been reached at the present time than is indicated by Exhibits "E" and "D." Drawbaugh does not attempt to locate the time at which he made any of these instruments, or even the year. He testifies, however, that he made all of them prior to the time the "Axle Company" commenced business, which was in December, 1874, except "E" and "D," which were made about that time.

The theory of the defendants is that Exhibits "F" and "B" were used by Drawbaugh in 1867, 1868 and 1869; Exhibit "C" in 1869 and 1870; Exhibit "I" in 1870 and 1871; Exhibit "A" in 1873 and 1874; and that Exhibits "E" and "D" were made in January or February, 1875, although cruder instruments essentially similar were made somewhat earlier. It is in proof that thirty-three patents were granted for improvements in telephones in 1878, 64 in 1879, more than 100 in 1880, and 94 in the first six months of 1881. According to the theory of the defendants, therefore, as early as February, 1875, Drawbaugh had not only distanced Bell in the race of invention, but also Gray and Edison, and had accomplished practically all that has since been done by a host of other inventors.

The case for the defendants must stand or fall by this theory. The proofs leave no room for fair doubt that defendants' contention is substantially true, or that the defence has no foundation in fact. It is true that Drawbaugh had long been treading his solitary path of investigation and experiment in poverty and obscurity, but had perfected his work when the inventions of other explorers were in embryo, or his story is an ingenious fabrication. And, as will hereafter appear, if the defence is a fabrication, many disinterested witnesses have contributed innocently to give it color and strength, but Drawbaugh has deliberately falsified the facts.

The complainant starts with the benefit of the presumption of law that Bell, the patentee, was the inventor of that for which the letters patent were granted to him. Whoever alleges the contrary must assume the burden of the proof. Evidence of doubtful probative force will not overthrow the presumption of novelty and originality arising from the grant of letters patent for an invention.

It has been frequently held that the defence of want of novelty or originality must be made out by proof so clear and satisfactory as to remove all reasonable doubt. Washburn *vs.* Gould, 3 Story, 227; Smith *vs.* Fay, 6 Fish, 446; Hawes *vs.* Antisel, 2 B. & A., 10; Patterson *vs.* Duffy, 20 Fed. Rep., 641; Wood *vs.* Cleveland Rolling Mill Co., 4 Fish, 560; Parham *vs.* American Button-hole Co., 4 Fish, 482; in U. S. Stamping Co. *vs.* Jarrett (18 Blatch., 469), Blatchford, J., said the defendant had not fulfilled "the necessary obligation of showing beyond any reasonable doubt" that Weber (the alleged prior inventor) was prior to Heath (the patentee). In Coffin *vs.* Ogden, 18 Wall, 129, Mr. Justice Swayne, delivering the opinion of the Court, stated the rule applicable to the defendant as follows: "The burden of proof rests upon him, and every reasonable doubt should be resolved against him."

To overthrow this presumption, and disprove that Bell was the first inventor, the defendants introduce the testimony of nearly 200 witnesses tending to prove the priority of invention by Drawbaugh. As the complainant concedes that Exhibits "E" and "D" are highly-organized practical telephone instruments, and fully capable of perfect articulation, the patents are invalidated if these instruments were in existence at the date of Bell's invention, and, as will hereafter appear, they were in existence as early as in 1875, or it is incredible that they existed at all until long after Bell's first patent had been granted, and his invention had attracted general public attention at the Centennial Exposition and elsewhere.

In the argument for the defendants, great stress is placed upon the evidence of a gradual and natural development of Drawbaugh's invention, shown by the original instruments produced, beginning with Exhibit "B" and ending with the perfect magnetos "E" and "D." It is strenuously urged that these exhibits fortify his testimony describing the instruments no longer extant, and mark the origin and culmination, beginning with the cup machine and Exhibit "F" of two separate lines of invention — one leading to the battery telephone, in which the undulatory vibrations are controlled by variations on the resistance of the circuit, and the other to the magneto telephone, in which the vibrations are created in the electromotive force of the current.

The general theory of the defence is substantiated by three classes of witnesses—those who heard of the existence of Drawbaugh's "talking machines" at various times, those who talked through the machines on various occasions or heard others talk through them, and those who attempt to identify one or more of the exhibits as the instruments they saw or used. Only an outline of their testimony will be given.

More than 50 witnesses testify to having heard of the talking machines prior to Feb. 14, 1879.

Of these witnesses three think they heard of them in 1869; three in 1870; two in 1871; five in 1872; three in 1873; three prior to 1873; eight in 1874; two in 1875; from 1866 to 1876, one; from 1868 to 1871, one; from 1868 to 1873, one; from 1869 to 1870, one; from 1869 to 1876, one; from 1871 to 1872, two; from 1872 to 1873, one; from 1873 to 1874, one; from 1873 to 1875, three; from 1874 to 1875, one; from 1874 to 1876, one; from 1872 to 1876, one; prior to 1869, one; prior to 1872, two; prior to 1875, one.

Sixty witnesses do not attempt to identify any particular instrument, but testify that they saw a talking machine, or talked through it, or heard it talked through at Drawbaugh's shop on occasions subsequent to 1867, and most of them fix the occasion as prior to 1876. The substance of the testimony of some of them will be given.

Wilson G. Fox testified that he saw the talking machine at Mr. Drawbaugh's shop about the year 1867 or 1868, when the old faucet company was in operation there. Prior to March, 1871, the witness was employed in the carding room of the Harrisburg cotton mill, and Drawbaugh came there to get material to wrap his wire to use for the talking machine. Henry Bonholtzer testified that he was at Drawbaugh's shop in 1869, and saw talking machines there. Margaret Bren-

neman testified that she saw the talking machines at Drawbaugh's shop in 1869. Abraham May testified that he did work on Daniel Hart's house at Milltown in August and September, 1870, of which he produces his account books; that he never did any work for Daniel Hart after that; that while doing that work he was at Drawbaugh's shop to get a boring machine mended which he was using in the work, and Drawbaugh showed him his talking machines, and talked through them from one floor of the shop to another. The witness understood and heard through the machines the words that Mr. Drawbaugh spoke into them. His testimony is corroborated by Jacob H. Kilmore, William H. Martin and John A. Smith. Cyrus Orris testified that he saw Drawbaugh's talking machines at different times from about the 1st of April, 1871, down to 1880, and took his son-in-law, Jacob E. Smith, to Drawbaugh's shop to see the machines about April 1st, 1871. Benjamin K. Goodyear testified that in 1871 he seized the personal property of George W. Kissinger, of Milltown, upon an execution issued November 13, 1871; that on December 4, 1871, the attached property was appraised, and on that day witness went to the workshop of Daniel Drawbaugh to find J. B. Drawbaugh to summon him as an appraiser, and had to wait for him there a short time; that while waiting there Daniel Drawbaugh showed him his talking machines, and talked through them to him, and witness heard him speak and understood distinctly the words that he spoke through the instrument, and that he was never in Drawbaugh's shop afterwards, so far as he can recollect. George Natcher testified that he lived at Milltown in 1871 and 1872, and never has been in the town since August 9, 1873; that while there living he was at Drawbaugh's shop, and saw and talked through the talking machine on different floors, and listened at the same machine and understood what was said through it. Mrs. B. B. Spangler, a sister of George Natcher, testifies that she moved away from Milltown in 1872, and never has been there since; that she talked into Drawbaugh's talking machines while she lived there, and that she was so small that Herman Drawbaugh had to lift her up to enable her to talk into the machine. Mrs. Mary Free testifies that she was with her sister, Mrs. Lydia Drawbaugh, at Drawbaugh's shop in September, 1872, when he talked through the machines to them, and she remembers hearing through the machines, "Good afternoon, ladies!" Drawbaugh told them that the machines operated by electricity. Mrs. Lydia Drawbaugh testifies that she saw the talking machines in September, 1872, her sister, Mrs. George Free, being present. David M. Ditlow, testifies that he saw Drawbaugh's talking machine about 1872, when Drawbaugh talked through it, and witness heard and understood through the machine what he said. David K. Ernest testifies that he was at Drawbaugh's shop with John B. Bloser about the middle of June, 1872, and talked with Drawbaugh about the talking machines, and thinks he saw them at that time. This testimony is corroborated by John Bloser. N. W. Kahney testifies that he saw the talking machines about 1872. William H. Martin testifies that he was at Milltown with John Keefauver to get George Hosler to make him a pair of boots. Hosler lived at Milltown only from March, 1872, to March, 1873. At that time witness and Mr. Keefauver went down to Drawbaugh's shop and talked through the talking machine from the basement to the attic, and heard and understood what was said through the machines. They talked and listened at the same instrument. John F. Keefauver corroborates Mr. Martin, and also states that he talked through Drawbaugh's talking machine with Jacob M. Sadler in April, 1873, prior to the death of George B Hick, and that about two or three years before he saw the talking machines he had heard a good deal about them, and first heard of them at a place seven miles west of Carlisle. Wm. W. Snyder testifies that he was at Drawbaugh's shop on Wednesday, February 5, 1873, and saw the talking machines. He verifies the date by an entry in his diary. Jacob Barber testifies that he was a candidate for the office of County Commissioner of Cumberland County in the summer of 1873, and in connection with his canvass went to Drawbaugh's shortly after the death of George B. Hick. While at Drawbaugh's shop he saw the talking machine, and was never in the shop after July or August, 1873. Ezekiel Worley testifies that about the year 1873 he saw the talking machines at Drawbaugh's shop. His statement is corroborated by John K. Taylor. Abraham Ditlow testifies that he knew of Drawbaugh's talking machine in 1874, and saw it and talked through it at that time. He had forgotten the fact, but was reminded of it by Mr. Alexander Milner, of Porter County, Indiana, whom witness told about it in May or June, 1876, in Indiana. William Eppley testifies that he visited Drawbaugh's shop for the last time in May or June, 1875; that he was there several times during the two years preceding that period, and had seen talking machines. Jonathan Fry testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Frederick in the winter of 1875-6, and saw the talking machines there. Jacob Evans testifies that he was at Drawbaugh's shop with his wife, his brother Andrew, and his sisters Margaret and Sarah, about December 1, 1875, and saw and talked through the talking machines. Henry L. Hamme testifies that he was at Drawbaugh's shop either in the last of January or the beginning of February, 1876, in company with George Frederick and Jonathan Fry, and saw and talked through the talking machine at the time; that he heard and understood very plainly what was said through the machines, even when Mr. Drawbaugh talked in a whisper. George Frederick testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Fry in January or February, 1876, and saw the talking machines. S. S. Rupp testifies that he was at Drawbaugh's shop with Mr. Hamacher and his scholars on February 1, 1876, and recollects that Mr. Drawbaugh at that time spoke about a machine that he had which he called a talking machine, but the witness was interested in otner things and did not pay much attention to it. Geo. H. Bowman testifies that he saw talking machines in Drawbaugh's shop in February, 1876, at which time somebody was talking to Mr. Drawbaugh through them. Charles L. Drawbaugh testifies that he saw and talked through the talking machines at Drawbaugh's shop a year or more prior to May 1, 1876, and heard and understood what was said.

That the talking machines referred to by the witnesses were electric instruments is clearly established. Drawbaugh testifies explicitly that they were always used with a closed circuit and without breaking the current, some of them being battery telephones, and some magneto telephones. He always represented them as actuated by electricity to those to whom he explained or described them, and claimed his invention would supersede the telegraph. His assertions show them to have been electrical instruments. He stated to the witness, Shank, "It was the greatest invention ever known. If he had the means to go on with it, they could talk, or rather be a time to come, as to talk to the old country same as we can talk here;" to Zacharias, that "he could run it out for miles, and parties could talk in it at one end and be heard at the other end the same as persons in a room together;" to Smith, that "parties between Harrisburg and Philadelphia could communicate as if they were speaking together; there would hardly be any limits;" it was an "instrument to convey the voice, to supply the place of the telegraph;" to Smyser, that it would work "from here to California"; to Fry, that one "can talk as far as the wire goes;" to Carl, that "he could hear a man talking from that place to New Cumberland or Harrisburg, and understand distinctly what he said"; to Sherick, that it was "better and handier than the telegraph; that you could just talk through it in place of writing"; to Blasley, that "by attaching two wires you can hear it away off; the telegraph is nowhere with it;" to Kahney, that "he could talk the same for miles as he could for short distances;" to Shetiel, that "if he had a wire from the shop in connection with the telegraph wires at White Hill he could talk to Mechanicsburg by having a machine there or an instrument in the office; that it would be better than telegraphing, and that it would be worth a great deal of money;" to Reneker, that "he thought he could make it that he could talk through to Harrisburg; he thought they would take the place of telegraphing;" to Weber, that "it beats all the others of my invention; he could carry sound, or rather talk as far as Shiremanstown;" to Hawn that "he would be able to operate, that a man preaching in New York, that a congregation in Philadelphia would hear the same sermon;" to Kahney, that "he could just as easy speak ten miles as one, or any distance he would choose to;" to Rupp, who was there with Hamacher that "it was worked by electricity; would take the place of the telegraph, and that he could make it so that he could talk to San Francisco;" to Mueser, that "he was going to make a machine to talk from Harrisburg to Philadelphia, and it would be a cheaper and quicker way than telegraphing"; that "he believed they could talk for a hundred miles;" to Fetterow, that "I could speak ten, fifteen or twenty miles, or even to California if there was a wire extended;" to Wisler, that "he could attach a wire to it and talk for ten miles, as far as he could have a circuit around;" to H F. Drawbaugh, that "he could talk across the continent;" to Free, that "the talking machine could be used to talk at a long distance, from Philadelphia to California;" to Landis, that "it could be used a thousand miles; it would take the place of the telegraph;" to Lenig, that "he could talk hundreds of miles through that;" to Updegraff, that "instead of using the old mode of telegraphing, he could talk directly through the wire; he thought he could talk as far as you could use the ordinary telegraph wire;" to Draper, that "he thought it was or would be one of the greatest inventions of the age, and would take the place of telegraphing;" to A. Evens, that "he could take this machine and talk clear out to Europe across the ocean;" to Eicholz, that "if he could only get some one to help him once he would run it to Harrisburg and convince them, and then he would run it from Harrisburg to Philadelphia. He stated to the witness Shank that "it works by electricity;" to Smith, that "it was by electricity;" to Nichols, that "the sound was conducted by electricity;" to C. Eberly, that "the instruments were to convey sound by electricity;" to Coudry, that "they were operated by electricity;" to Shoop, that "it operated by a battery;" to Shireman, that "they operated by magnetism;" to Hawn, that "they would be operated on by a battery;" to N. W. Kahney, that "the machine was operated by electricity by a battery;" to Zimmerman that "it was electricity that would pass it over the wires; that it would carry the sound right along;" to Hale, that "it was driven by a magnet;" to H. K. Drawbaugh, that "the sound could be carried to a distance on a wire by the use of electricity;" to Lenig, that "electricity was used in connection with it;" to Prof. Heiges, that "in connection with a talking machine both magnetism and electricity were applied;" to Goodyear, that "his talking machine was also done by electricity over wire;" to Woods, that "it was to be an electric machine used in place of telegraphing;" to Young that "it was an electric talking machine which he had invented."

Thus Drawbaugh is corroborated by a cloud of witnesses whose testimony tends to substantiate his narrative. Without stopping at this point to consider the credibility and probative force of their testimony, it suffices to state that although some of the witnesses seem to have been reckless and unscrupulous in their statements the great body of them are undoubtedly honest witnesses. It is impossible, however, to believe that Drawbaugh can be mistaken in the substance of his testimony, and the conclusion cannot be ignored that either his testimony is true in its essential parts, or his narrative has been manufactured to fit the exigences of the case. In order to ascertain what effect is to be given to the corroborative proofs it is important to determine whether Drawbaugh is an honest witness, or whether he has intentionally falsified collateral facts, and is therefore to be deemed discredited.

If the defence is to be believed, he had been experimenting with his talking machine from 1866, and had successfully transmitted speech as early as 1870, if not before that time. He testifies that he had used Exhibits "B" and "F" in transmitting speech for two or three years before he made Exhibit "C." According to the theory of the defendants Exhibit "C" was made in 1869 or 1870 At that time he had reached a secondary stage in the development of his invention, and certainly as early as 1872, when Exhibit "C" had received its latest modifications, the invention had passed out of the period of rudimental forms embodying principle merely into a form embodying nice details of construction and had reached a perfection not reached by Bell in his earlier patent. Drawbaugh was well aware of the merit and of the great pecuniary value of the invention; he had obtained patents for several inventions of minor value, yet from 1870 until July, 1880, he did not apply for a patent for the telephone. It was of the first importance to explain the reason of his inaction, because it seems incredible that the inventor of the telephone should not only omit to patent it as soon as he could, but should also remain silent for years after others were winning the fame and profits of the invention. Only one explanation was possible, and that has been attempted. As stated in the answer and in his testimony, it is that he was unable to do so by reason of his poverty. The answer alleges "that for more than ten years prior to 1880 he was miserably poor and utterly unable to patent his invention or caveat it." He was asked the question: "Do you mean to have it understood from your last answer that there was any other reason for some period prior to 1870, except your poverty, whether greater or less, which prevented you from patenting your invention, or filing a caveat for it?" His answer was: "If I understand that right, there was no other reason that I can think of now." He proceeds to state that Exhibits "F" and "B" exhibited the principle perfectly enough to patent. In the elaborate efforts of the defendants to substantiate the theory of Drawbaugh's inability from poverty to patent his invention, much testimony has been produced to show, and which does show, that he was always more or less in debt, often a borrower of small sums of money, was dilatory in paying his debts and used to plead his inability when dunned, and was often sued and judgment and executions were obtained against him, but it is clear from a few plain facts that the theory of extreme poverty is unfounded, and that Drawbaugh is dishonest in putting it forward. In 1867 and 1869, besides what he received for his wages, he received $5,000 from the Pump Company for his faucet invention, besides $1,000 in the stock of the concern. On the 1st day of April, 1869, he received $1,000 from one Gardner for the sale of a half interest in a faucet invention. He invested $2,000 of the $5,000 in real estate, lost $400 of it in an apple speculation, and used the $1,000 received from Gardner to buy a house and lot for his father. Between 1867 and 1873 he paid $1,200 to the Drawbaugh Manufacturing Company for assessment on his stock, besides $870 in labor; and in July, 1873, received from that company $425 cash in settlement of its affairs. From 1867 to April, 1872, he was the owner of real estate for which he had paid $5,300 in the fall of 1867, and upon which he expended in improvements in the spring of 1868 from $300 to $400, and which was encumbered only by a prior lien for $300. In the spring of 1872 he encumbered it for $1,000, not as a principal but as a surety. He was in receipt of $110 annually, as rent for a part of this property, occupying the rest himself, until he sold it in 1876 and bought another house in the town of Mechanicsville. He was always in receipt of fair wages for his labor. From April 1, 1875, to April 1, 1876, he received nearly $450 for wages from the Axle Company, irrespective of his earnings from other sources, and declined steady work at times because he could make more by job work. Thus it appears that, although it was not convenient at times for him to pay his debts, or he was careless or indifferent, he had not only the means of raising money during all this period, but that on many occasions he had means for investment and for speculation. The pretence that he could not raise the fees to caveat or patent his invention is transparently absurd.

He was accustomed to prepare specifications of patents, and was a maker of models, and advertised himself as an inventor, designer and solicitor of patents. During the time he was experimenting on his talking machine, and before he applied for a patent, he found time and materials for experimenting with and making the Gifford injector for steam engines, the autograph telegraph, the magneto dial telegraph, the magneto key, the automatic fire-alarm, and the electric clock. During this period he was a friend of Mr. Weaver, a patent solicitor, who frequently gave him advice and professional assistance in return for mechanical services rendered by Drawbaugh, and who drew specifications for him for a measuring faucet and for the magnetic clock. If he was not competent himself to make an application for the patent, it cannot be doubted that with the assistance of Weaver he could have made a proper application at a trifling outlay, if any, beyond the fees of the office.

Drawbaugh devoted a good deal of time between 1867 and 1878 to the invention and construction of his electric clock, and the time and money expended by him in experimenting and constructing this clock in its various forms, especially those made in 1877, and 1878, was much more than would have enabled him to patent his talking machine. These clocks were built by him with his own tools and out of his own money, and to build them economically he made a gear cutting machine, which must have cost him more than it would to patent his telephone. In April, 1878, he received $509 from the Electric Clock Company for the privilege of using his clock invention.

In order to fortify the theory of Drawbaugh's inability from poverty to patent his invention the defendants have attempted by testimony from him and from others to show that he was extremely solicitous to patent it, and tried to induce others to furnish the means. Mr. Springer testifies that "his (Drawbaugh's) whole mind appeared to be on his talking machine; he told me that many a night he didn't sleep just studying how to improve it." After May, 1872 according to the testimony of Jacob Hawn, the talking machine superseded the clock in Drawbaugh's interest. According to Mr. Holsinger, from 1873 to 1876, "he appeared to be crazy on it; I often tried to get information from him on other subjects and about a half minute's talk would turn him right on the talking machine." Henry F. Drawbaugh, his brother, testifies "Every time I was down there from the summer of 1872 to 1879 or 1880, he was working at it and talking, and wanted me to go in with him and furnish means." Mr. Bates says he was in Drawbaugh's shop eight or ten times between the summer of 1874 and the fall of 1877, and "his general conversation was about the talking machine; said he would like to get it patented but had not the means, and could make a fortune out of it." Drawbaugh testifies as follows: "Question. A good many witnesses have testified that you were at various times talking of patenting your electric speaking telephone invention; what is your recollection about that, did you intend to patent it or not? Answer. Yes, sir, I intended to patent it. I had spoken to a number of persons to assist me. I would state to them that I would give them an interest in the invention for them to furnish the money to have it patented, Question. Why did you not patent it with your own money? Answer. I did not have any money. Question. At how early a time did you have the intention of patenting it? Answer. I could hardly say how early. I spoke to persons even at early time. I spoke to Chris

tion Eberly; it may have been prior to 1870 I spoke to Frank Lee; I spoke to them about taking an interest. They were among the earliest. I can't remember all the persons as I had spoken to a great many." Lee is not a witness, having died in 1872. Christian Eberly locates the time as between 1867 and 1870. He had been a partner with Drawbaugh in a number of inventions and was a capitalist. He was asked: "When Mr. Drawbaugh showed you his talking machine state whether he proposed to you to go into partnership with him and furnish the money for that also as you had before that time on the other inventions?" He answered: "Not altogether; he intimated that he would take me in. I don't recollect as I said anything, or what I said." The witness was often in Drawbaugh's shop subsequently, in 1871, 1872 and 1873, but mentions no other propositions. The only other persons Drawbaugh specifies as having been applied to by him are Capt. Moore, Henry Bayler and Simon Oyster. Oyster was not called as a witness. Captain Moore was examined as a witness for the defendants and his testimony is significant. He was the principal of the Soldiers' Orphan School, an institution in the vicinity of Eberly's Mills, and was the secretary and treasurer of the Axle Company, a concern that in part occupied Drawbaugh's shop in 1875 and 1876. He testifies that in May, 1875, Drawbaugh showed him a talking machine; said he was unable to patent it himself, and desired witness to "go in with him and get a patent." He states that he told Drawbaugh he didn't want to go into any new invention, but that it would be a fortune to any person bringing it out if it could be put to practical use. He identifies Exhibit "B" as the machine shown him at that time by Drawbaugh. Although he and Drawbaugh maintained intimate business relations for a year after that time the subject seems never to have been referred to again. Mr. Moore was an intelligent capitalist. It is strange that Drawbaugh should have shown him Exhibit "B," the crude instrument of 1867–1869, if the perfect instruments "E" and "D" were in existence; and more strange that the subject was never mentioned again between them if they had any faith in the value of the invention. Mr. Bayler, the other witness, carried on lumbering and a saw-mill from 1873 to 1877 in the vicinity of Milltown and employed Drawbaugh frequently to repair machinery. He testifies that in June, 1873, Drawbaugh showed him the talking machine, and he said to Drawbaugh, "Why, Dan, that is virtually a talking telegraph," and advised him to take out a patent for it, to which Drawbaugh replied: "If I had the means I would; if you'll advance me the means to procure a patent I'll give you a half interest." The witness continues: "Generally on him meeting me he would urge it urge me to take an interest by furnishing him the means to take out a patent." He also identifies Exhibits "F" and "B" as the instruments shown him by Drawbaugh. But his books show that during all the time from April 1873, to May, 1876, he owed Drawbaugh more than the fees necessary for producing a patent.

The defendants produce other witnesses to prove that from 1870 to 1879 Drawbaugh was showing his telephone, adverting to his poverty, and trying to induce somebody to assist him. Mr. Herr may be cited as an illustration. He testified that in 1870 or 1871 Drawbaugh wanted money to get a caveat to secure his invention, and told the witness if he would help him or procure any person to assist him he would give him a half interest. Without adverting further to the testimony on this subject, it is sufficient to say in view of the fact, that there never was a time from 1867 to 1880 when Drawbaugh did not have the money to caveat and patent his invention, or the means of borrowing it. The only legitimate effect of such testimony is to discredit the whole defence by exciting the suspicion that it is bolstered up by exaggerated and unreliable testimony. It will hereafter be shown that among the men with whom Drawbaugh maintained business and friendly relations during this period, there were many of intelligence and means. Some of them may have distrusted his judgment, and regarded him as a visionary. Some of them may have been indifferent or timid. But it is incredible that, when only a trifling sum was required for a half interest in the invention, none of them could be sufficiently impressed with its merit or financial value to investigate it seriously as a speculation or an investment. He induced persons to invest in faucet inventions and in his magnetic clock; and it cannot be true that he could find no one to entertain the talking machine which, according to the common rumor of the neighborhood, was to supersede the telegraph, and, in the words of one of the witnesses, "make Drawbaugh one of the richest men in Cumberland Valley." It was very natural that a hard-headed old farmer like William Daer, on being told by Drawbaugh that he had a machine by which he could talk across the Atlantic Ocean, should advise him to "try it first in talking across the Yellow Breeches Creek," but it is beyond comprehension or belief that none of the capitalists or speculators about him could be induced to seriously consider it if it was an operative device.

Where a witness falsifies a fact in respect to which he cannot be presumed liable to mistake, courts are bound upon principles of law, morality and justice, to apply the maxim, *Falsus in uno, falsus in omnibus.*" The Trinidad, 7 Wheat. 283. Drawbaugh could not be mistaken in asserting that it was his poverty which prevented him from caveating or patenting his invention. He was not led to the assertion inadvertently. Those with whom he is associated in the defence understood fully, and so did he, that the fact that a professional inventor and patentee did not go to the patent office to secure an invention like the telephone for ten years after it had been completed and demonstrated was almost conclusive against the theory that he made the invention, and that unless this presumption could be parried no court would credit his story. The theory of constraining poverty was therefore formulated in the answer, elaborately fortified by witnesses, and testified to by Drawbaugh. It is overthrown by a few plain, indisputable facts, and Drawbaugh's veracity falls with it.

The defence must rest upon the testimony of the witnesses who corroborate Drawbaugh. The case made by these witnesses is sufficiently formidable to overcome the legal presumption of the validity of the complainant's patents. It is met by the complainant with rebutting evidence, direct and circumstantial, showing the intrinsic improbability of the theory that Drawbaugh was the inventor of the telephone, and showing his conduct or declarations inconsistent with any hypothesis that he was more than an unsuccessful experimenter with the invention. Many witnesses have also been produced by the complainant to attack the credibility and reliability of the testimony of the defendant's witnesses. Of necessity the testimony of most of the defendant's witnesses can only be attacked by showing that witnesses are mistaken as to the time when they saw Drawbaugh's talking machine, or as to what they really saw on the occasions they refer to The way in which the testimony of Uriah P. Nichols is met will illustrate the general tenor of such testimony. Mr. Nichols was one of the most intelligent and trustworthy of the defendant's witnesses, a farmer and machinist, who testified that on the 18th day of January, 1875, he visited Drawbaugh's shop on business, saw two instruments which he identified as Exhibits "B" and "A," and described their mode of operations as stated to him by Drawbaugh at the time; he says he listened at one instrument while a boy spoke into another two hundred feet away, connected by wires, and heard the boy say, "Is it you, father, speaking?" The complainant produces nine witnesses to show that the occasion could not have been prior to February, 1878. * * * * * In cases where such a chaos of oral testimony exists, it is usually found that the judgment is convinced by a few leading facts and indicia outlined so clearly that they cannot be obscured by prevarication or the aberrations of memory. Such facts and indicia are found here, and they are so persuasive and cogent that the testimony of a myriad of witnesses cannot prevail against them.

The first group of facts of this nature are those which bear upon the capacity and character of Drawbaugh as an inventor, and tend to show that it is not only highly improbable, but almost impossible, that he could have been the author of the telephone.

In the summer of 1878 he composed a biography of himself for publication in the History of Cumberland County, which presents a graphic picture of the inventor and of the man. He commences by describing himself as "born in the quiet, secluded village of Milltown, three miles from Harrisburgh," and as one of the greatest inventive geniuses of this age, who has spent the greater part of an active life conceiving and producing as the result of the conceptions of an unusually fertile brain a score of useful, ingenious machines and devices. It appears, he says, "by examining a list of his inventions, that the manufacturing interests of the place in his boyhood days gave direction to his thoughts and incentive to his action." He proceeds to enumerate a list of his inventions as follows: "His first invention was an automatic sawing machine, then a number of machines used in wagon making, then a machine for boring tenons, then a machine for sawing tenons, a barrel-stave jointing machine, patented 1851 (this machine was pretty generally introduced and its merits appreciated); an automatic grinding machine was next invented to meet a demand created by the introduction of the jointer; then followed several machines for making stave headings and shingles, all of which were patented in 1855; after which machines for rounding, beading, crozing, dressing and finishing outside of barrels, were invented; these were again followed by a device for running millstones, one for dressing mill stones, a device for elevating grain in mills. He then invented and had patented four improvements in nail-plate feeding, next a tack machine and a new design in tacks. Photography next engaged his attention. He fitted himself for action in this field by manufacturing his own camera, ground and fitted achromatic lenses for camera, prepared the necessary chemicals, and improved the process for enlarging pictures. Next electricity and electric machinery attracted his attention, and an electric machine was produced, throwing out of consideration the galvanic battery and electric pile; then a machine for alphabetical telegraphing; then the justly-celebrated electric clock and the machinery necessary for its construction, and several kinds of telephones, one of which is operated by battery and another by induction." He concludes as follows: "It will be seen from the foregoing that Mr. Drawbaugh has penetrated vast fields in search of information, and with what success we leave the reader to determine. We are proud to own Mr. D. as a citizen of our township, and deem him worthy of a position at the head of our prominent men, and are happy to accord him that position." This portrait, drawn by himself, depicts without the aid of extrinsic evidence the ignorance and vanity of the man, and the incongruous and fantastic assortment of his inventive projects. It suggests, also, the character of a charlatan.

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When the speaking telephone was first introduced to the attention of the scientific public, it was pronounced by one of the most eminent electricians of the day "a result of transcendent scientific interest," and "the greatest by far of all the marvels of the electric telegraph." The inventions attributed to Drawbaugh include not only the conception of the principle of the unbroken, undulatory electric current, and of the delicate and complex instrumentalities essential to its efficient application in transmitting and reproducing articulate speech, but also of many other devices involving a nice adjustment of forces and requiring sensitive mechanism. These were inventions of a peculiarly scientific order which would seem to demand a special conversance with the principles of acoustics and electricity. Besides making the cardinal discovery of the theory of the unbroken undulatory current, Drawbaugh is assumed to have perfected a brilliant and extraordinary series of original discoveries for which, to use the words of Mr. Benjamin, "there is no parallel instance in the whole history of invention." Mr. Benjamin, referring to the microphone which was introduced to the public in 1878 by Mr. Blake, but which is one of the instruments asserted to have been invented by Drawbaugh at an earlier date, says, "It was looked upon as a great and original discovery." * * None of Drawbaugh's alleged discoveries were made by accident. His statement is, that starting with the belief that speech could be transmitted by electricity, he made first one contrivance and then another, gradually obviating difficulties and making advances experimentally until he finally perfected the several inventions.

In view of Bell's special equipment for investigation and experiment in electrical and acoustic science it would not seem strange that his persistent efforts tried to effect the electrical transmission of speech, were eventually successful, were it not that others as intelligent, as well equipped, as ingenious and as persevering as he, had devoted years to the same object in vain. He had the assistance of Mr Watson an expert in electricity and a skilled workman in electrical mechanism, in constructing the apparatus employed in his experiments, and who also aided him in his experiments. He had demonstrated his inventive proficiency by inventions in telegraphy for which patents were granted to him. And yet had it not been for an accidental discovery made by him in June, 1875, and which would probably have escaped one whose trained faculties were not centered on a careful study of the phenomena, he might have failed.

Drawbaugh, on the other hand, was not only untutored, but he was isolated by his associations and occupations from contact with men of advanced science; he had narrow opportunities for instruction, and few incentives for profound research. Among the multitude of his inventive conceptions was one that a talking machine was a possibility. According to the testimony of Lory, a witness for defendants, before Drawbaugh began his practical experiments he exhibited a sketch of a machine that he was about to make that would talk a distance of twenty miles and work something like a telegraph. If this is true he commenced on his telephone as the architect plans a building or the engineer makes a draught of his structure. His own testimony shows that he did not attempt to qualify himself for electrical inventions by any systematic study after he began experimenting with his talking machine. Although he had undoubtedly acquired considerable desultory information about electricity, and especially about the mode of operation and detail of construction of electrical mechanism, it is obvious that when he commenced with his talking machine he was a tyro in electrical science, essaying the most difficult work of the electrician. It is almost incredible that the subtle intellectual discoveries which were a closed book to the ablest electrician could have been reached by a smatterer in science, or by any series of empirical experiments.

As has been remarked, he seems to have discovered nothing accidentally, yet from the beginning to the end of his narrative there is nothing to indicate the conceptive origin or the mental growth of the alleged invention. He presents a number of devices in the chronological order of their production and testifies that he made one, and then another and another, as experiments led him to modifications and improvements. He cannot describe what receiver or other apparatus he used with his first transmitter, and testifies: "I had a number of crude apparatuses, but can't remember exactly the shape of any of them. I had membranes stretched over hoops—over a hoop, I remember that; and I had electro-magnets, and the arrangement was varied; I don't remember exactly the arrangement." He testifies that when he used the cup machine he used it in a continuous electric circuit, and thinks he used it as a receiver with exhibit 'B" as a transmitter. He states that he succeeded in transmitting speech with these two instruments, and, of course, he could only have done this by employing the unbroken undulatory currrent of electricity. He cannot state how he conceived the initial ideas of the undulatory current and the continuous circuit, or subsequently the theory of any of the remarkable devices which he produces. His answers to questions intended to elicit such information may be illustrated by giving one of them: "I don't remember how I came to it; I had been experimenting in that direction; I don't remember of getting at it by accident either; I don't remember of anyone telling me of it; I don't suppose anyone told me." He produces sketches, or models, or originals of instruments which he says he made from time to time; he states that they were used to talk through on various occasions, and from these outlines of accomplished facts leaves the history of his inventions to be filled out by inference and conjecture. An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement; but Drawbaugh's memory is a blank. If the untutored mechanic educated himself into an accomplished electrician by his own experiments and observations, the incidents and phenomena which revealed new discoveries and illumined the way for new advances would be indelibly impressed upon his mind. It seems little short of the miraculous that a man of his capacity and equipment should have produced these inventions at all; more marvelous still that he should have produced them without any intellectual perception of his discoveries.

Another group of important facts which are satisfactorily shown by the proofs are those which indicate Drawbaugh's own knowledge that he was not an original inventor of the telephone. Reference has been made to some of the evidence bearing upon his neglect to patent or caveat his invention in discussing the question of his credibility as a witness.

If no honest and reasonable explanation can be given for his conduct the inference is very strong that he knew he did not have a practical telephone to patent. He may have had a talking machine which was well calculated to excite the curiosity of the community in which he lived; he may have indulged in expectations that in time he could succeed in making a practical speaking telephone, and reap fame and profit from it; but his conduct is almost decisive against the supposition that he had even deluded himself with the belief that he had produced anything sufficiently practical and valuable to patent. He never attempted to exhibit it outside of his own shop to prove that it would transmit speech at a distance of even a quarter of a mile. The proofs show that during all the years from 1867 to 1873 he did not attempt to avail himself of opportunities for demonstrating his invention and bringing it to the notice of friends who were peculiarly qualified to appreciate, and were favorably circumstanced to assist him. One of these persons was Mr. Keifer, who resided at Harrisburg from 1863 to 1881, and during that period had charge of the telegraphs of the Pennsylvania Railroad Company, and was a member of a firm whose business was the manufacturing of fine electrical machinery. In 1873 he put up a fire alarm system for that city. Drawbaugh made his acquaintance in 1874 or 1875, and brought his magneto fire alarm to Mr. Keifer for examination. At another time brought the works of his electric clock. He visited Mr. Keifer on various occasions, obtained small supplies from him, and habitually conversed with him upon the subject of his electrical contrivances. The period of these visits begins just about the time when, according to the theory of the defendants, Drawbaugh had constructed Exhibits "E" and "D," and the invention was complete. He never mentioned to Mr. Keifer the fact that he had experimented with a telephone. Mr. Wilson was superintendent of telegraphs for the Northern Central Railway Company at Harrisburg from 1864 to 1875. He was also Mayor of Harrisburg. The company had an electrical workshop and supply establishment there for Mr. Wilson's department between

1871 and 1875. During this time Drawbaugh often came to the supply shop and talked with Mr. Wilson about electrical experiments, and obtained parts of batteries, coils, magnets, and other electrical material which the company had cast aside. He brought Mr. Wilson his electric clock and his magneto-electric key, and tried his machine for short line telegraphing at Mr. Wilson's office; he talked with him frequently about his inventions, but he never mentioned the telephone. His relations with David A. Houck were such that the latter procured him an opportunity to test his magneto key at the telegraph office of the railroad company at Mechanicsburg. Mr. Stees was the superintendent of a car company at Harrisburg, having shops in different parts of the city connected by telegraph lines. He was the first person to employ Bell's telephones on these lines when they were introduced into Harrisburg late in 1877 or early in 1878. He was a friend of Drawbaugh, and Drawbaugh would naturally have applied to him if he wanted to test his telephone publicly or practically. Isaac Lloyd was a school teacher and an alderman at Harrisburg; had known Drawbaugh long; was accustomed to visit his shop from time to time; saw many of Drawbaugh's inventions; was present on one occasion when Drawbaugh experimented with his magneto device for telegraphing at Mr. Wilson's telegraph office. Drawbaugh visited him frequently, and they were accustomed to converse about Drawbaugh's inventions. Drawbaugh showed him his dial telegraph, his electric fire alarm apparatus, and numerous other inventions. Witness assisted him about the electric clock. He was an owner of patents, and a friend to whom Drawbaugh applied for loans, and was interested in mechanical subjects generally. The only mention ever made to him by Drawbaugh about a telephone was in 1878, when Drawbaugh told him he was experimenting with a telephone. From 1867 to July, 1873, Drawbaugh was intimately connected with the persons composing the Drawbaugh manufacturing Company, which was engaged in manufacturing devices under Drawbaugh's patents. He was a stockholder and the master mechanic of this company. Among the officers and stockholders were many men of capital and enterprise. There came a time when the managers of the company wanted Drawbaugh to suggest new devices for the company to manufacture. He never suggested the telephone nor attempted to induce the managers of that company to investigate or exhibit his talking machine. A number of the managers and employes of this concern testify that they never heard of the existence of the talking machine during the life of the company. Without attempting to refer to other testimony to the same general effect, what has already been referred to shows that if Drawbaugh had seriously desired to bring his talking machine into public notice and secure the fruits of his invention he had ample opportunity to do so. Who can doubt that if he had a practical telephone to exhibit he would have selected just such men as Keifer, Wilson, and the others, to demonstrate it to them and enlist them to demonstrate its utility and value to the public.

Such an invention was of a kind calculated to excite public interest, and to impress practical men with a quick appreciation of its commercial importance and its pecuniary value. It was sufficiently perfected, according to the theory of the defence, that a patent could have been obtained prior to 1870 to secure the application of the principle, and to compel every subsequent inventor to pay tribute to the discoverer of a new art. For years it was mechanically perfect, and its efficiency and importance as a great factor in human intercourse could have been demonstrated to the public without appreciable inconvenience or expense. Drawbaugh fully appreciated its importance and value. He had the means to patent it himself and friends to assist in introducing it into public use. He had the talent to induce others to invest in his inventions. No explanation is possible why, under such circumstances, his efforts should have left no mark upon the annals of inventive progress, and given no evidence of life beyond the idle curiosity his talking machine excited in the circle of his admirers during all these years. His conduct is more persuasive to show that he did not have a practical, operative telephone, than the testimony of a multitude of witnesses who may have seen and heard talking machines at his shop during this period. But the complainant has given evidence of his declarations made by him before he had any interest to pervert the truth which afford a reasonable explanation of his conduct and go far to explain how the testimony of the corroborative witnesses may be reconciled with the truth.

In 1874–6 Drawbaugh issued a business card advertising himself as "Inventor, designer and solicitor of patents." On the back of this card is printed a list of his inventions as follows: Stave heading and shingle cutter, barrel machinery, stave jointing machine; train and red-staff for leveling face of mill-stones; line and driver for running mill-stones; nail machinery for feeding nail plates; pumps, rotary and others; hydraulic ram, the Drawbaugh rotary measuring faucet; carpet rag looper, electric clock and magneto electric machine for short line telegraphing and fire alarm and propelling electric clocks. He takes pains to say of this magneto machine on his card that it can be applied to any form of electric movement, and dispenses with a galvanic battery. He had obtained patents for some of these inventions but had not for others. He was then experimenting with his electric clock and with his magneto machine for short line telegraphing, fire alarms, etc., and including them in the list of his inventions. The omission to mention the most important one of all of his inventions, one respecting which, according to his present testimony, there had not been a week from the time he made his first cup machines that he had not been engaged with it, one which was complete before his electric clock was complete, is a significant statement by implication that he had no such invention to advertise.

It is to be remembered that when he chronicled his achievements in the autobiographical sketch of 1878, the Bell telephone had been introduced into commercial use at Harrisburg, three miles from Drawbaugh's shop, and the local newspapers had been full of the subject. The cursory allusion in that autobiography to "several kinds of telephones" is in striking contrast with the elaborate description of the electric clock, and wholly inconsistent with the theory that he deemed himself to be the originator of the invention which at that particular time was a topic of universal interest.

In his testimony given in 1879 in the interference proceeding with Hauck, although he did not include the talking machine in the category of his successful inventions, in the course of his testimony he produced a sketch of his faucet, and stated that he made it "about 1874 to 1876 when I was experimenting on telephones or phonographs." He represented himself not as an inventor of that which he is now claimed to have perfected, but as an experimenter with a "telephone or phonograph." It is instructive to read this statement in juxtaposition with a statement made by him to Mr. Matthews in the preceding year. Mr. Matthews was the managing editor of the Baltimore *American*, and in April, 1868, made a visit to Drawbaugh at his shop to see Drawbaugh's magnetic clock in consequence of information received from a correspondent. He was a careful observer, who went there obviously for the purpose of writing an article for his paper. That his memory is unusually retentive and accurate and that he is a careful and conscientious man is apparent from a letter written by him in December, 1883, after the proofs in the case had been closed, and in which he manifests a desire to correct certain errors of detail in his deposition. Upon that visit his attention was chiefly directed to the clock, but he examined Drawbaugh's other inventions, and conversed with him about them, and, among other things, conversed about the telephone. Drawbaugh's statement to him on that occasion was that he had invented an apparatus to send messages by means of an alphabet founded upon difference of sounds. He did not profess to be the inventor of the speaking telephone, or assert that he had ever transmitted speech successfully with his apparatus. He said that the idea of transmitting sounds in this manner was not new, and he had read of it some years before in a publication translated from the French, and denied Bell's right to claim the invention of the telephone, because of that publication. In the article founded on that interview, which Mr. Matthews subsequently wrote for publication in the Baltimore *American* he adverts to the several useful agricultural and mechanical devices patented by Drawbaugh, and adds: "It may be mentioned that Mr. Drawbaugh constructed a rude telephone long before Mr. Edison loomed up as the 'boss' inventor. He never expected to send articulate sounds over a magnetized wire, but he believed that an alphabet could be arranged after the manner of the musical scale, and that messages could be transmitted and understood by the variations of tone and pitch. This unlettered mechanic came very near anticipating Edison and Bell in the invention of the telephone, and nothing but his poverty prevented him from conducting his experiments to a successful issue."

His advertising card, his testimony before the Patent Office, his autobiography, and his statement to Matthews authenticated in writing were all made when he had no pecuniary interest to color the facts, and upon occasions when he was anxious to present himself in the most favorable light as an inventor; and they were all made after his talking machine, according to the theory of the defendants, was a perfected invention, and known to be such by many of his friends and neighbors.

These are declarations evidenced in writing, and one of them made under oath, which point in but one direction. They are consistent with his conduct. They show that he understood himself to be an experimenter with telephones or phonographs, but not the inventor of the speaking telephones.

The complainant has supplemented this evidence by the testimony of other substantial witnesses who had favorable opportunities to know what Drawbaugh had invented, and who describe what they saw and did not see at his shop, and narrate what he said about his talking machine on various occasions. This testimony indicates that at as late a period as in 1878–79 Drawbaugh was an experimenter, but not the author of the parent invention, nor one who had perfected any valuable improvement upon it; and is in substantial accord with his statement to Mr. Matthews, and his testimony in the interference proceedings. What gives point and force to this testimony and carries the ordinary objections to the reliability of verbal declarations is that these witnesses are persons who would have been forcibly impressed because of their interest in the particular subject by any assertion by Drawbaugh that he was an inventor of the telephone. During the time in question Drawbaugh had friendly relations with the newspapers of the vicinity; his friends were frequently communicating laudatory notices of his mechanical and inventive efforts to the press, and he himself visited one of the newspaper offices in the spring of 1878 to show a telephone he had made. These newspapers had published articles about the Bell telephone, but up to the spring of 1878, while many notices had been published in them about his electric clock and other inventions, describing him as a man of extraordinary genius, there had been no mention of the telephone, and when, in the spring of 1878, the subject was mentioned, he was referred to as one who was "inventing a telephone on a different plan from that now occupying the attention of the scientists," and as about completing the new telephone he is now constructing.

* * * * * *

No doubt is entertained that Drawbaugh was experimenting at an early period with telephones or phonographs. He knew about the phonograph or phonautograph of Scott as early as in 1863. The membrane diaphragm excited by sonorous waves and the electric mechanism of the phonographs were not novelties, and, among the diversity of inventive possibilities, had probably attracted his interest. Prior to 1869 Dr. Van Der Weyde had made public experiments with the Reis telephone at the City of New York, and others had made like experiments elsewhere. In May, 1869, a full description of the instrument and of the experiments was published in the newspaper, the *Manufacturer and Builder*, treating it as a highly-interesting curiosity, which contained the germ of great practical purposes. Whether other newspapers noticed the experiments or not is not shown, nor is it shown that Drawbaugh saw the article in the *Manufacturer and Builder*. It would be difficult to prove the circumstance if he did see it. Some such publication probably stimulated him to experiment. If he made a sketch of the mechanism at the start, the material for it was at hand. As is stated by Mr. Benjamin, it has been asserted of the Reis instrument that certain sounds of the human voice can be transmitted by it, but in truth these are merely fragmentary reproductions of vocal sounds, and the transmission of articulate speech could not be effected because it was constructed on the make-and-break principle, instead of on that of the undulatory, unbroken current.

It is not strange to any reader of the autobiography that Drawbaugh should have taken up the telephone. That he, and those about him, should have treated it as a talking machine is entirely natural. That his talking machine as late as in 1876 bore a striking resemblance to the Reis telephone is shown by Mr. Shapley's testimony, a witness who noticed the resemblance, and loaned Drawbaugh a copy of the *Scientific American* describing it.

There is enough here to explain Drawbaugh's declaration to his neighbors about the talking machine he was inventing, and to excite the curiosity of the community. A careful reading of the proofs renders it easy of belief that the witnesses who testify about casual visits to his shop, which occurred many years before their testimony was delivered, and to cursory tests of his instruments on those occasions, have confused the fragmentary and incoherent articulation of such an apparatus with the hearing of distinct words and sentences. When witnesses undertake (as many of them do) to give the exact word or sentence heard in the instrument five or ten years before, when their attention was not called to the subject afterwards, no hesitation is felt in rejecting such statements as utterly incredible. It may be charitably inferred that such a witness has confused his recollection with more recent impressions. As will hereafter be shown, the proofs demonstrate that most of the witnesses who testify to having heard distinctly and coherently through the talking machine—all those who indicate the Exhibits "B," "F" and "C" as the instruments—are mistaken if they are truthful. If Drawbaugh was a charlatan, he may have assisted in deluding them, and the proofs show that between 1872 and 1874 a string telephone was in his brother's shop, in the village. The fact that he never attempted to exhibit his machine outside of his shop, where it could be used between points some considerable distance apart, and where its real capacity could be readily observed, is significant in this connection.

The more important testimony is that by which it is sought to identify the several exhibits, and show their existence at times consistent with theory of the natural evolution of the invention. The identification of particular exhibits as seen by the witnesses among the various objects of curiosity at Drawbaugh's shop several years before they testify is necessarily unreliable, when it is attempted by observers who had no knowledge of the mode of operation or of the internal organization of the instruments. Such witnesses could not appreciate what they saw even if they examined the instruments. Most of the witnesses belong to this class. Indeed, the greater portion of them do not profess to identify the exhibits positively. Some are more certain than others that particular exhibits are the instruments they saw. Exhibits "F," "B" and "C" are fragmentary remains of instruments, and their value depends upon Drawbaugh's description of the operative parts that no longer exist. Scores of witnesses testify to seeing the teacup device resembling Exhibit "F," and the tin can device resembling Exhibit "B," but the identification of the other exhibits prior to the date of Bell's patent is comparatively feeble.

* * * * * *

The proofs on both sides lead to general conclusions that Drawbaugh was not an original inventor of the speaking telephone, but had been an experimenter without obtaining practical results until the introduction of the instruments into Harrisburg. It is very probable that after reading in the *Scientific American*, loaned by Mr. Shapley in October, 1876, the article purporting to describe Bell's telephone, but which really described better the Reis apparatus, he undertook to improve his old devices. At that time, or after, he had examined the telephone instruments at Harrisburg and carried one of them home to study. he may have altered the organization of his instrument, and made the intermediate exhibits between "F" and "D." If he exhibited them at his shop, and was able to transmit speech through them, this fact will account for the testimony of the witnesses who identify those exhibits, and may be mistaken as to the time they saw them. The real history of this talking machine is known only to himself, and will not be profitable to conjecture when he made the advanced instruments which he claims to have made in February, 1875, and the later instruments.

It may be that in discrediting his narrative and rejecting the theory of the facts which rest upon it, the value of the corroborative testimony has been underestimated. However this may be, no doubt is entertained as to the conclusions which should be reached upon the proofs.

Succinctly stated most favorably for the defendants, the case is this: One hundred witnesses more or less testify that on one or more occasions which took place from 5 to 10 years before, they think they saw this or that device used as a talking machine; they are ignorant of the principle and of the mechanical construction of the instruments, but they heard speech through them perfectly well and through one set of instruments as well as the other. This case is met on the part of the complainants by proof that the instruments which most of the witnesses think they saw and heard through, were incapable of being heard through in the manner described by them, and further, that the man who knew all about the capacity of his instruments never attempted to use them in a manner which would demonstrate their efficiency and commercial value, and on the contrary, for ten years after he could have patented them, and for five years after they were mechanically perfect, knowing all the time that a fortune awaited the patentee, and with no obstacles in his way, did not move, but calmly saw another obtain a patent and reap the fame and profit of the invention.

Without regard to other features of the case it is sufficient to say that the defence is not established so as to remove a fair doubt of its truth; and such doubt is fatal.

The observation of an eminent commentator may be quoted as apposite to the case: "No form of judicial evidence is infallible, however strong in itself; the degree of assurance resulting from it amounts only to an infinitely high degree of probability, and perhaps as many erroneous judgments have taken place on false or mistaken direct testimony as on presumptive proof." Best's Evidence, § 468.

A decree is ordered for complainant.

—— It is said that the holiday market will soon be stocked with a novelty in the way of a low-priced electric lamp to be worn as a scarf pin. The lamp is connected by a wire to a small pocket battery.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING DECEMBER 2, 1884.

308,595 Double Carbon Lamp; J. Allan Dalzell, New York, N. J.

308,601 Armature core for dynamo-electric machines; Frederick K. Fitch, New York, N. Y., assignor to the Fitch Electric Lighting and Construction Company, of same place.

308,610 Polarized telegraphic relay; Wirt B. Harvey, Memphis, Tenn.

308,612 Underground conduit for electric conductors; Edwin J. Houston, Philadelphia, Pa., assignor to the Thomson-Houston Electric Company, New Britain, Conn.

308,620 Electric arc lamp; Norman McCarty, Brooklyn, N. Y., assignor to the Electrical Supply Company, Ansonia, Conn.

308,660 Arm rest for telephone uses; John M. Fitch, Detroit, Mich.

308,712 Electric light fixture; Jonathan H. Vail, New York, N. Y.

308,713 Electric light conductor for structures; Jonathan H. Vail, New York, N. Y.

308,731 Electric device for synchronizing clock pendulums; Henry L. Bailey, Brooklyn, assignor to the Time Telegraph Company, New York, N. Y.

308,754 Reed for harmonic telegraphs; Frederick W. Cushing, New York, N. Y.

308,793 Electric clock; Chester H. Pond, New York, and Henry L. Bailey, Brooklyn, assignors to the Time Telegraph Company, New York, N. Y.

308,817 Telephone transmitter; Granville T. Woods, Cincinnati, Ohio, assignor of two-thirds to Lewis M. Hosea and David Humphreys, both of same place.

308,832 Dynamo-electric machine; Elisha B. Cutten, Kingsbridge, N. Y., assignor to the Electrical and Mechanical Developing Company, Pittsburgh, Pa.

308,835 Dynamo multiplex Telegraphy; Stephen D. Field, New York, N. Y.

308,845 Electric railway signal; Jose Lloret Y. Tepes, Madrid, Spain.

308,851 Armature for dynamo-electric machines; Benjamin F. Orton, New York. N. Y.

A printed copy of the specification and drawing of any patent to the annexed list, also of any patent issued since 1865, will be furnished by any of the patent solicitors whose advertisements appear in this journal. In ordering please state the number and date of the patent desired.

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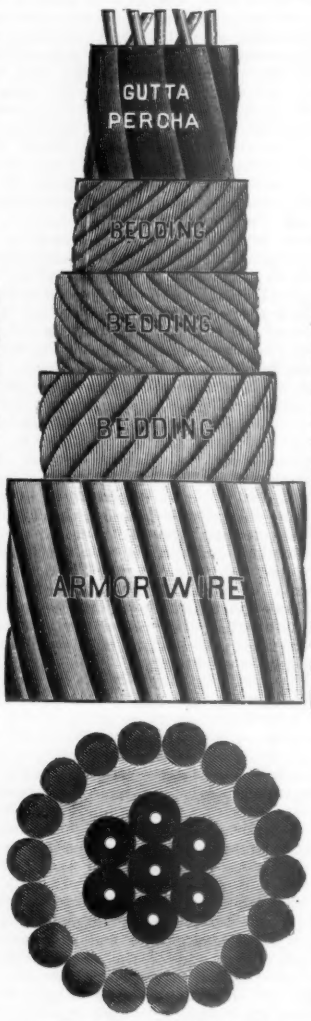

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